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ABSTRACT

The mathematical derivation of the statistics used for inference in some linear models assumes that the values of the independent variables are measured without error. This assumption is often disregarded when these models are utilized in research. This study is an investigation of the consequences of the violation of this assumption for one family of linear models on the magnitude of these statistics and the frequency of Type I error in these models. The results of this study indicate that although the frequency of Type I error in these models is relatively unaffected, the values of the statistics are seriously affected by the concomitant variable being other than error-free. (Author)

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AN EMPIRICAL INVESTIGATION OF SOME EFFECTS OF THE VIOLATION OF THE ASSUMPTION THAT THE COVARIABLE IN ANALYSIS OF COVARIANCE IS MEASURED WITHOUT ERROR

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The mathematical derivation of the statistics used for inference in some linear models assumes that the values of the independent variables are measured without error. This assumption is often disregarded when these models are utilized in research. This study is an investigation of the consequences of the violation of this assumption for one family of linear models on the magnitude of these statistics and the frequency of Type I error in these models. The results of this study indicate that the frequency of Type I error in these models is relatively unaffected, and the values of the statistics are probably not seriously affected by the concomitant variable being other than error free. However, an inadequacy in the procedure cause any conclusions to be of a tentative nature.

AN EMPIRICAL INVESTIGATION OF SOME EFFECTS OF THE VIOLATION OF THE ASSUMPTION THAT THE COVARIABLE IN ANALYSIS OF COVARIANCE IS MEASURED WITHOUT ERROR[1]

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R. A. Fisher, who conceived the statistical technique analysis of covariance (Fisher, 1932), stated that "it [analysis of covariance] combines the advantages and reconciles the requirements of two widely applicable procedures known as regression and analysis of variance" (Fisher, 1973, p. 283). Although this combination of regression and analysis of variance is obvious in most presentations of analysis of covariance from an applications point of view, the contributions of regression to the set of assumptions for analysis of covariance are seldom mentioned. This study involves two of the often neglected assumptions of analysis of covariance which stem from the role played by regression.

In a linear model context analysis of covariance can be thought of as a data reduction procedure in which characteristics or performance of objects or individuals can be described in terms of statistics which occur as coefficients in an appropriate linear model and as an inferential procedure for contrasting certain of the statistics which have been obtained by the solution of the model for a particular set of data. In such a data

[1]This paper represents a report of one aspect of a continuing empirical research effort concerning certain aspects of the analysis of covariance procedure. The author would like to recognize and thank the following persons for their various contributions to this research: Marshall Adams, Jacqueline W. Calkins, Lorraine Matteson, Eugene Schuster, and the computation center staff at The University of Texas at El Paso.

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reduction procedure, the statistics describing the characteristics or performances of objects or individuals classified in a particular manner by a given value or given values of the independent variable or variables can be seen to be based on the attributes of a joint frequency distribution of the dependent variable and concomitant variable(s). Such statistics are obtainable through the mathematical fit of an appropriate function to the space generated by the data occurring for the dependent variable and concomitant variable(s) for each grouping of objects or individuals defined by a particular value of the independent variable or by particular values of the independent variables.

Comparison of objects or individuals classified in a particular manner by a value of the independent variable or values of the independent variables can be visualized geometrically as comparison of these joint frequency distributions and more specifically as comparison of the attributes of the mathematical functions obtained for each frequency distribution. Such comparisons of these groups can be quantitatively accomplished in terms of assessing the probability that differences among the appropriate statistics which occur in the linear model as summaries of the frequency distributions do not exist for the populations from which the groups were obtained. These probabilities can be obtained through evaluation of $\underline{F}$ statistics which are calculable as functions of the amount of error in one model in which differences in the appropriate statistics are allowed to exist and another model which has been constrained to eliminate the differences to be examined.

The simplest case of analysis of covariance is the most usual application of this technique. In this case there is a single concomitant variable and a single independent variable, and a linear relationship is the most appropriate mathematical function with which to fit the data for each group. Since the latter condition implies that the relationship between the dependent variable

and the concomitant variable is linear, it can be readily seen that a true model for this case must contain an intercept and a slope for each value of the independent variable. Obviously, comparisons among the various groups, which are defined by the independent variable, must be accomplished in terms of differences among the group slopes and intercepts.

The following procedure is intended to demonstrate how such comparisons can be accomplished when certain assumptions involving the variables are met. To test for differences among the group slopes, the F statistic from the expression

$$F_{slopes} = \frac{(q_2 - q_1) / df_1}{q_1 / df_2}$$

can be calculated and evaluated where q_1 is the error sum of squares for the true model which contains a slope and intercept for each group; q_2 is the error sum of squares for a model which contains an intercept estimate for each group but the same slope estimate for all groups (this restricted model constrains each group to have the same slope, thus eliminating all group slope differences); df_1 is a number with a magnitude one less than the number of groups; and df_2 is a number with a magnitude equal to the summation of the number in each group reduced by two (Ward and Jennings, 1973, pp. 138-148). To test for differences among the group intercepts when the group slopes are not different, the F statistic from the expression

$$F_{intercepts} = \frac{(q_3 - q_2) / df_1}{q_2 / df_3}$$

can be calculated and evaluated where q_2 is the error sum of squares for the restricted model presented above; q_3 is the error sum of squares for a model which contains the same intercept estimate and the same slope estimate for each group (this further restricted model constrains each group to have the same intercept and the same slope, thus eliminating all group intercept and

group slope differences); df_1 is a number (as above) with a magnitude one less than the number of groups; and df_3 is a number with a magnitude equal to the summation of the number in each group reduced by a number one less than the number of groups (Ward and Jennings, 1972, pp. 138-148).

Although particular interpretations of differences among group slopes and intercepts depend upon particular situations, some general interpretations are as follows:

1. The occurrence of differences in the group slopes implies that the rate of change of the dependent variable with respect to the concomitant variable differs for the various groups.
2. The occurrence of differences in the group intercepts when the group slopes are not different implies that there are constant differences among the groups in terms of the dependent variable for each value of the concomitant variable.

Generally comparisons of group intercepts are of little interest if the group slopes are different, because in this situation differences among the groups are variable, since the difference depends on particular values of the concomitant variable.

In order to show the inherent distributional assumptions involving the variables for analysis of covariance when there is only a single concomitant variable, the relationship between the dependent and concomitant variables is linear, the group slopes are not different, and there is only one independent variable, the following model for analysis of covariance as presented by Graybill (1961, pp. 383-384) will be used. "The model is

$$y_{ij} = \mu + \tau_i + \beta x_{ij} + e_{ij} \qquad \begin{matrix} j = 1, 2, \ldots r \\ i = 1, 2, \ldots t \end{matrix}$$

where y_{ij} is an observed random variable; x_{ij} is an observed fixed quantity, usually called a <u>concomitant variable</u>; μ is a constant; τ_i is the ith treatment constant; β is the regression coefficient (unknown); and e_{ij} are unobserved

normal variables that are independent and have means 0 and constant variances σ^2." Examination of this model and its assumed distributional properties reveals that (1) the dependent variable y is assumed to be a random variable measured without error; (2) the concomitant variable x is assumed to be a fixed variable measured without error; and (3) β is a constant for all treatment groups. The model is essentially the one discussed previously in which all groups were constrained to have the same group slope.

In addition, Graybill (1961, pp. 384-396) shows that when the data conform to the distributional assumptions of the model, many desirable mathematical properties result. It is only as a consequence of these resulting mathematical properties that the descriptive and inferential uses of analysis of covariance are viable. Unfortunately, it seems that little pertinent research by the mathematical statisticians is available to indicate what consequences are to be expected when the data do not conform to the distributional assumptions of the model.

For the usual application of such models by researchers, the assumptions involving error free measurement of the dependent and concomitant variables and the necessity that the concomitant variable be a fixed variable are often neglected. Previous research (Calkins and Jennings, 1972) has indicated that the consequences of the violation of the assumption that the concomitant variable is fixed are probably of little practical importance to investigators concerned with estimation of slopes and intercepts and Type I error resulting from contrasts of slopes and intercepts. In the research presented in this paper, some of the consequences of the violation of the assumptions that the concomitant variable is quantified in an error free manner and that the concomitant variable is fixed and quantified in an errorless manner have been investigated.

PROCEDURE

This research was conducted in much the same manner using essentially the same computer programs as the previous investigation in this series (Calkins and Jennings, 1972). Since complete details of the procedure were presented in the previous investigation, this procedure section will be abbreviated, and persons interested in more details may consult that paper.

The set of models investigated are those discussed previously in this paper in which the true model contains one independent variable and one concomitant variable which is linearly related to the dependent variable. The investigation of the effects which occur in these models when the concomitant variable contains error, or contains error and is not a fixed variable, was restricted to possible disturbance of (1) the distributions of the slopes and intercepts, and (2) the distributions of the $\underline{F}$ statistic utilized for decisions concerning possible differences in the slopes and intercepts. Possible disturbance of the distributions of the slopes and intercepts were examined through the calculation of functions of the first four cumulative moments of their respective distributions, the mean, variance, skewness and kurtosis. Theoretically it is expected that the slopes and intercepts will be distributed normally with the following values:

$$\text{Expected mean for slopes} = \frac{\rho_{xy} \cdot \sigma_y}{\sigma_x}$$

$$\text{Expected variance for slopes} = \frac{\sigma_y^2\ (1 - \rho_{xy}^2)}{\sigma_x^2\ \ (n - 2)}$$

$$\text{Expected mean for intercepts} = \mu_x - \frac{\rho_{xy}\sigma_y}{\sigma_x}\ \mu_y$$

$$\text{Expected variance for intercepts} = \frac{n}{2(n-1)^2}\ \ \frac{\sigma_y^2}{\sigma_x^2}\ (1 - \rho_{xy}^2)\ (\sigma_x^2 + \mu_x^2)$$

(approximate formula)

where n is the sample size

ρ_{xy} is the correlation for the population

μ_x and μ_y are the marginal population means for the x and y populations

σ_x and σ_y are the marginal population standard deviations for the x and y populations.

Possible disturbance of the distributions of the F statistic utilized for decisions concerning possible differences in the slopes and intercepts were examined through comparison of the mean of the observed sampling distributions with the theoretical values and comparison of the number of observed values for the distributions of F's for slope and intercept which were equal to or greater than the specific values of the central F distribution for the proper degrees of freedom at the .05 and .01 confidence levels. Since in this investigation all the samples were drawn from the same population, the expected values of $F_{intercept}$ should be near $df_3/(df_3 - 2)$ and F_{slope} should be near $df_2/(df_2 - 2)$ where df_2 and df_3 were previously defined in this paper. In addition, approximately five per cent of the values observed for $F_{intercept}$ and F_{slope} should be equal to or greater than the specific values of the central F distribution for the appropriate degrees of freedom at the .05 level and approximately one per cent should be equal to or greater than the equivalent value at the .01 level.

This empirical research, which was performed with the indispensable help of a digital computer, is of the Monte Carlo type. The computer system utilized was a CDC 3150 located at The University of Texas at El Paso. The FORTRAN programs written for this series of investigations function to (1) generate multiple pairs of values which simulate random samples of X,Y pairs from bivariate populations of values with various characteristics; (2) combine these pairs of values into samples of specified size; (3) calculate various quantitative indices on the data for and between the samples which correspond

to the quantitative indices resulting from the descriptive and inferential use of the linear models presented previously; (4) tabulate these indices for a specified number of experiments, each including a specified number of samples, in order to obtain a frequency distribution for each index; (5) calculate descriptive characteristics for each frequency distribution; and (6) produce output showing the frequency distributions and their descriptive characteristics. In this procedure, error in the covariable was introduced by generating a pair of X and Y values which had suitable characteristics for a certain condition of the experiment and then adding a component of error which was a random normal deviate from a population with zero mean and specified variance to each X value.

The characteristics of the bivariate populations which are specifiable with this set of programs and which were varied in this investigation are (1) sampling procedure for the covariable (random or fixed); (2) distribution shape of the covariable (normal or rectangular); (3) amount of error in the covariable (in terms of the standard error of measurement as a function of percent of standard deviation of Y -- 0%, 33%, 67%, and 100%); (4) variance of the Y values in each X array (in terms of standard error of estimate as a function of correlations of .0, .30, .60, and .90); and (5) sample size (samples of 5, 13 and 39 X,Y pairs were used). The characteristics of the bivariate populations which are specifiable but were not varied in this investigation are (1) means of the X and Y marginal distributions (maintained at or near 50); (2) number of groups obtained for each experiment (each experiment consisted of the data obtained for two groups with each group containing either 5, 13 or 39 X,Y pairs); and (3) number of experiments (1000 experiments were conducted for each of the possible combinations of the characteristics of the bivariate populations).

It was intended that the standard deviations of the X and Y marginal distributions be maintained at or near 10., but procedural constraints interfered to some extent. However, as an attempt to compensate for this lack of control, two sets of theoretically expected values for the mean and variance of the distributions of slope and intercept are presented in the Results section; one set is based on the intended population values and the other set is based on observed values. Comparison of these values should indicate to some degree the extent of this problem or the adequacy of the entire procedure.

Since it is always desirable in any scientific enterprise to maintain constant as many variables as possible, in this series of investigations it would be desirable to maintain constant the X variance for all experimental conditions. However, these constant variances are difficult to achieve, especially for the fixed X condition (at least from the author's current cognitive set). This difficulty occurs because for the fixed X case it must be decided whether it is more important to maintain a constant variance for the covariable or to use the same fixed X values for the various sample sizes. In the first investigation in this series (Calkins and Jennings, 1972), the same set of X values were used for all the fixed X cases for the two distribution shapes by varying the frequency of occurrence of each X value, but in this procedure the variances of the X values were allowed to vary. (The peculiar choice of X,Y pairs per sample -- 5, 13 and 39 -- is a byproduct of this procedure.) In the present investigation, a compromise between maintaining constant variance and the same set of fixed X values was effected, and as a consequence neither objective was fully attained. In this investigation fairly constant variance for the zero error condition was achieved by allowing the set of fixed X's to differ for different sample sizes, but when the X values contained a component of error the variance of the X values was to some extent uncontrolled. Some control over the variance

in this procedure could be established by a linear transformation of the X values containing error by subtracting a different constant for each quantity of error and each sample size, but such a transformation would destroy the concept of one set of fixed $\underline{X}$'s for all experimental conditions. (The author would appreciate comments concerning this problem.)

RESULTS

The results are presented in Tables 2 through 25. Tables 2-5 present the results of the experiments involving the investigation of the distributions of slopes for the several experimental conditions for the concomitant variable normally distributed with each table representing a particular value of error of estimate. Table 6-9 contain the same information as Tables 2-5 except that in these tables the concomitant variable is uniformly (rectangularly) distributed. Tables 10-13 present the results of experiments involving the investigation of the distributions of intercept for the several experimental conditions for the concomitant variable normally distributed with each table representing a particular value of error of estimate. Tables 14-17 contain the same information as Tables 10-13 except that in these tables the concomitant variable is uniformly (rectangularly) distributed. Tables 18-21 present the results involving the critical statistics for comparison of slopes and intercepts for the several experimental conditions for the concomitant variable normally distributed with each table representing a particular value of error of estimate. Tables 22-25 contain the same information as Tables 18-21 except that in these tables the concomitant variable is uniformly (rectangularly) distributed. Table 1 presents explication of the terms and abbreviations found in Tables 2-25.

Proper interpretation of these results can reveal the consequences of three aspects of the violation of assumptions concerning the concomitant

TABLE 1

Explication of Terms and Abbreviations
Found in Tables 2 through 25

1. Expect T - expected values based on specified characteristics of the bivariate populations

2. Expect O - expected values based on observed characteristics of the populations (example - the expected value for intercepts is calculable by subtracting the mean of the frequency distribution containing 2000 slopes multiplied by the mean of the frequency distribution containing 2000 X marginal means from the mean of the frequency distribution containing 2000 Y marginal means)

3. Error - standard error of measurement as a function of percent of standard deviation of Y values

4. RN - values of X (the concomitant variable) were obtained by random sampling from a normal distribution

5. FN - values of X (the concomitant variable) were preselected (fixed) such that they have zero skewness and kurtosis

6. RR - values of X (the concomitant variable) were obtained by random sampling from a uniform (rectangular) distribution

7. FR - values of X (the concomitant variable) were preselected (fixed) such that the values have equal frequency (rectangularly distributed)

8. Mean F - mean value of the observed frequency distribution of F values

9. I-Error - number of Type I errors observed at the .05/.01 level of significance

[illegible] BIVARIATE NORMAL POPULATIONS, [illegible] SAMPLE SIZES, [illegible] VALUE OF ERROR OF [illegible]

SAMPLE SIZE

		N=5			N=13			N=39		
		EXPECT T	EXPECT C	OBSERVED	EXPECT T	EXPECT C	OBSERVED	EXPECT T	EXPECT C	OBSERVED
	MEAN	0.0	-0.0050	-0.0064	0.0	0.0200	0.0209	0.0	0.0003	-0.0005
	VAR	0.5774	0.5736	0.6061	0.3015	0.3017	0.3215	0.1644	0.1638	0.1673
RN	SKEW	0.0	0.0	-0.2153	0.0	0.0	-0.0412	0.0	0.0	0.0124
	KURT	0.0	0.0	2.6233	0.0	0.0	0.3187	0.0	0.0	0.1732
ERROR = 0										
	MEAN	0.0	0.0102	0.0155	0.0	-0.0050	-0.0053	0.0	-0.0003	-0.0003
	VAR	0.5774	0.5386	0.4979	0.3015	0.3306	0.3159	0.1644	0.1594	0.1720
EN	SKEW	0.0	0.0	0.0024	0.0	0.0	-0.0098	0.0	0.0	-0.0939
	KURT	0.0	0.0	0.1397	0.0	0.0	-0.0495	0.0	0.0	0.1181
	MEAN	0.0	-0.0039	-0.0136	0.0	0.0183	0.0188	0.0	-0.0011	-0.0012
	VAR	0.5774	0.5452	0.6653	0.3015	0.2865	0.3025	0.1644	0.1556	0.1507
RN	SKEW	0.0	0.0	-0.4989	0.0	0.0	-0.1023	0.0	0.0	-0.0077
	KURT	0.0	0.0	9.1810	0.0	0.0	0.4684	0.0	0.0	0.0983
ERROR = 33										
	MEAN	0.0	0.0081	0.0076	0.0	-0.0098	-0.0091	0.0	0.0007	0.0012
	VAR	0.5774	0.5231	0.4988	0.3015	0.3045	0.3071	0.1644	0.1478	0.1493
EN	SKEW	0.0	0.0	-0.0968	0.0	0.0	-0.1169	0.0	0.0	0.1257
	KURT	0.0	0.0	0.3662	0.0	0.0	0.4635	0.0	0.0	0.2442
	MEAN	0.0	-0.0224	-0.0146	0.0	0.0067	0.0061	0.0	-0.0028	-0.0029
	VAR	0.5774	0.4767	0.6243	0.3015	0.2521	0.2641	0.1644	0.1358	0.1344
RN	SKEW	0.0	0.0	2.7930	0.0	0.0	0.0394	0.0	0.0	0.0736
	KURT	0.0	0.0	45.2763	0.0	0.0	0.9852	0.0	0.0	0.2261
ERROR = 67										
	MEAN	0.0	0.0125	0.0187	0.0	0.0041	0.0046	0.0	-0.0048	-0.0051
	VAR	0.5774	0.4480	0.4929	0.3015	0.2524	0.2669	0.1644	0.1104	0.1149
EN	SKEW	0.0	0.0	0.4654	0.0	0.0	0.1317	0.0	0.0	0.0091
	KURT	0.0	0.0	4.3253	0.0	0.0	0.5754	0.0	0.0	0.3672
	MEAN	0.0	-0.0135	-0.0173	0.0	0.0043	0.0035	0.0	0.0016	0.0012
	VAR	0.5774	0.4048	0.5008	0.3015	0.2116	0.2212	0.1644	0.1160	0.1137
RN	SKEW	0.0	0.0	-2.3842	0.0	0.0	0.0019	0.0	0.0	0.0503
	KURT	0.0	0.0	41.4469	0.0	0.0	0.4162	0.0	0.0	0.2220
ERROR = 100										
	MEAN	0.0	-0.0065	0.0020	0.0	0.0003	0.0009	0.0	0.0015	0.0020
	VAR	0.5774	[illegible]	0.5451	0.3015	0.2021	0.2170	0.1644	0.0839	0.0713
EN	SKEW	0.0	0.0	[illegible]	0.0	0.0	-0.0033	0.0	0.0	-0.0534
	KURT	0.0	0.0	[illegible]	0.0	0.0	1.3571	0.0	0.0	0.7876

THE SAMPLING DISTRIBUTION OF SLOPE FOR BIVARIATE NORMAL POPULATIONS, ... SIZES, FOUR AMOUNTS OF ERROR, AND A ...

SAMPLE SIZE

		N=5			N=13			N=39		
		EXPECT T	EXPECT T	OBSERVED	EXPECT T	EXPECT C	OBSERVED	EXPECT T	EXPECT C	OBSERVED
	MEAN	0.3000	0.2940	0.3180	0.3000	0.2982	0.3031	0.3000	0.2982	0.3020
	VAR	0.5504	[illegible]	0.6301	0.2876	0.2900	0.3042	0.1568	0.1573	0.1635
	SKEW	0.0	0.0	0.0125	0.0	0.0	-0.0450	0.0	0.0	-0.0779
	KURT	0.0	0.0	5.6637	0.0	0.0	0.8004	0.0	0.0	0.3244
ERROR= 0										
	MEAN	0.3000	[illegible]	0.2692	0.3000	0.2829	0.2344	0.3000	0.2933	0.2972
	VAR	0.5504	0.5165	0.4633	0.2876	0.3134	0.3078	0.1568	0.1522	0.1539
	SKEW	0.0	0.0	0.0135	0.0	0.0	0.0558	0.0	0.0	0.0607
	KURT	0.0	0.0	-0.0198	0.0	0.0	0.1913	0.0	0.0	0.1581
	MEAN	0.3000	[illegible]	0.2741	0.3000	0.2605	0.2707	0.3000	0.2565	0.2704
	VAR	0.5503	0.5333	0.6373	0.2876	0.2769	0.2981	0.1568	0.1496	0.1532
	SKEW	0.0	0.0	0.8701	0.0	0.0	-0.0357	0.0	0.0	0.0753
	KURT	0.0	0.0	13.0067	0.0	0.0	0.8162	0.0	0.0	-0.0193
ERROR= 33										
	MEAN	0.3000	[illegible]	0.2705	0.3000	0.2523	0.2663	0.3000	0.2195	0.2257
	VAR	0.5505	0.4939	0.4701	0.2876	0.2962	0.2965	0.1568	0.1426	0.1473
	SKEW	0.0	0.0	0.0663	0.0	0.0	0.1018	0.0	0.0	0.0749
	KURT	0.0	0.0	0.0051	0.0	0.0	0.3286	0.0	0.0	0.2692
	MEAN	0.3000	0.1747	0.2054	0.3000	0.1999	0.2032	0.3000	0.2085	0.2108
	VAR	0.5504	0.4764	0.5695	0.2876	0.2451	0.2528	0.1558	0.1323	0.1321
	SKEW	0.0	0.0	-0.1059	0.0	0.0	-0.0482	0.0	0.0	0.0286
	KURT	0.0	0.0	8.2005	0.0	0.0	0.5690	0.0	0.0	0.2315
ERROR= 67										
	MEAN	0.3000	0.1814	0.2246	0.3000	0.1752	0.1862	0.3000	0.1258	0.1308
	VAR	0.5503	0.4418	0.4765	0.2876	0.2430	0.2560	0.1558	0.1078	0.1135
	SKEW	0.0	0.0	0.1160	0.0	0.0	0.0353	0.0	0.0	0.2316
	KURT	0.0	0.0	2.1005	0.0	0.0	0.7815	0.0	0.0	0.3991
	MEAN	0.3000	0.1231	0.1405	0.3000	0.1422	0.1434	0.3000	0.1495	0.1516
	VAR	0.5504	0.3675	0.4603	0.2876	0.2077	0.2154	0.1568	0.1147	0.1173
	SKEW	0.0	0.0	0.1214	0.0	0.0	-0.0557	0.0	0.0	0.0460
	KURT	0.0	0.0	3.7064	0.0	0.0	0.2637	0.0	0.0	0.3506
ERROR=100										
	MEAN	[illegible]	0.1244	0.1470	0.3000	0.1124	0.1215	0.3000	0.0737	0.0776
	VAR	0.5500	[illegible]	0.5029	0.2876	0.2016	0.2125	0.1568	0.0330	0.0925
	SKEW	0.0	0.0	[illegible]	0.0	0.0	0.1604	0.0	0.0	0.2056
	KURT	0.0	0.0	[illegible]	0.0	0.0	0.5822	0.0	0.0	0.3013

TABLE 4. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

SAMPLE SIZE

			N=5			N=13			N=39		
			EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
ERROR= 0	RN	MEAN	0.6000	0.5454	0.6003	0.6000	0.5845	0.6023	0.6000	0.5958	0.6012
		VAR	0.4610	0.4374	0.5815	0.2412	0.2475	0.2525	0.1315	0.1331	0.1335
		SKEW	0.0	0.0	0.5441	0.0	0.0	0.0189	0.0	0.0	-0.1021
		KURT	0.0	0.0	10.1311	0.0	0.0	0.6620	0.0	0.0	0.1191
	FN	MEAN	0.6000	0.5705	0.6053	0.6000	0.5774	0.5905	0.6000	0.5934	0.5972
		VAR	0.4610	0.4420	0.5905	0.2412	0.2672	0.2580	0.1315	0.1362	0.1374
		SKEW	0.0	0.0	0.0312	0.0	0.0	0.0156	0.0	0.0	0.0376
		KURT	0.0	0.0	-0.1357	0.0	0.0	-0.1098	0.0	0.0	-0.1348
ERROR= 33	RN	MEAN	0.6000	0.4900	0.5312	0.6000	0.5320	0.5486	0.6000	0.5371	0.5423
		VAR	0.4610	0.4657	0.5250	0.2412	0.2407	0.2483	0.1315	0.1291	0.1331
		SKEW	0.0	0.0	-0.2511	0.0	0.0	0.0179	0.0	0.0	0.0344
		KURT	0.0	0.0	4.2112	0.0	0.0	0.6477	0.0	0.0	0.1587
	FN	MEAN	0.6000	0.5148	0.5561	0.6000	0.4951	0.5159	0.6000	0.4465	0.4563
		VAR	0.4610	0.4248	0.3385	0.2412	0.2536	0.2584	0.1315	0.1249	0.1339
		SKEW	0.0	0.0	0.1883	0.0	0.0	0.2107	0.0	0.0	0.2898
		KURT	0.0	0.0	0.1651	0.0	0.0	0.1190	0.0	0.0	0.4465
ERROR= 67	RN	MEAN	0.6000	0.5772	0.4200	0.6000	0.3913	0.4055	0.6000	0.4073	0.4112
		VAR	0.4610	0.4200	0.5052	0.2412	0.2209	0.2296	0.1315	0.1184	0.1191
		SKEW	0.0	0.0	0.2403	0.0	0.0	0.0262	0.0	0.0	0.0002
		KURT	0.0	0.0	4.1073	0.0	0.0	0.5560	0.0	0.0	0.0208
	FN	MEAN	0.6000	0.3906	0.4448	0.6000	0.3351	0.3551	0.6000	0.2534	0.2634
		VAR	0.4610	0.3967	0.4138	0.2412	0.2214	0.2201	0.1315	0.1015	0.1186
		SKEW	0.0	0.0	0.5304	0.0	0.0	0.2973	0.0	0.0	0.2715
		KURT	0.0	0.0	1.7340	0.0	0.0	0.4058	0.0	0.0	0.5806
ERROR=100	RN	MEAN	0.6000	0.2757	0.3096	0.6000	0.2398	0.2909	0.6000	0.2384	0.3012
		VAR	0.4610	0.3794	0.4614	0.2412	0.1949	0.1992	0.1315	0.1060	0.1062
		SKEW	0.0	0.0	-2.0428	0.0	0.0	0.0913	0.0	0.0	-0.0654
		KURT	0.0	0.0	34.3229	0.0	0.0	0.5938	0.0	0.0	0.0550
	FN	MEAN	0.6000	0.2775	0.3215	0.6000	0.2139	0.2259	0.6000	0.1449	0.1514
		VAR	0.4610	0.3507	0.4140	0.2412	0.1365	0.1373	0.1315	0.0795	0.0979
		SKEW	0.0	0.0	0.0514	0.0	0.0	0.1310	0.0	0.0	0.2764
		KURT	0.0	0.0	[illegible]	0.0	0.0	1.0381	0.0	0.0	0.6212

[illegible] 5. [illegible] OF THE SAMPLING DISTRIBUTION OF SLOPE FOR BIVARIATE NORMAL POPULATIONS, [illegible] SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF [illegible] CORRELATION OF 0.90

SAMPLE SIZE

		N=5			N=15			N=39		
		EXPECT T	EXPECT θ	OBSERVED	EXPECT T	EXPECT θ	OBSERVED	EXPECT T	EXPECT θ	OBSERVED
	MEAN	0.9000	0.8700	0.9025	0.9000	0.8928	0.9009	0.9000	0.8971	0.8993
	VAR	0.2517	0.2420	0.2900	0.1314	0.1357	0.1381	0.0717	0.0722	0.0727
[illegible]	SKEW	0.0	0.0	-0.0196	0.0	0.0	-0.0601	0.0	0.0	-0.0125
	KURT	0.0	0.0	2.2073	0.0	0.0	0.3540	0.0	0.0	0.2267
[illegible] = 0										
	MEAN	0.9000	0.[illegible]	0.[illegible]	0.9000	0.8937	0.9004	0.9000	0.9000	0.9005
	VAR	0.2517	0.224[illegible]	0.2198	0.1314	0.1427	0.1385	0.0717	0.0736	0.0720
[illegible]	SKEW	0.0	0.0	0.[illegible]91	0.0	0.0	0.0406	0.0	0.0	-0.0775
	KURT	0.0	0.0	0.0151	0.0	0.0	-0.0789	0.0	0.0	-0.0921
	MEAN	0.9000	0.8502	0.8900	0.9000	0.7996	0.8098	0.9000	0.8092	0.8124
	VAR	0.2517	0.2005	0.2994	0.1314	0.1543	0.1553	0.0717	0.0815	0.0823
[illegible]	SKEW	0.0	0.0	-0.3130	0.0	0.0	0.0122	0.0	0.0	0.1035
	KURT	0.0	0.0	3.6308	0.0	0.0	0.4552	0.0	0.0	0.2101
[illegible]R = 33										
	MEAN	0.9000	0.8056	0.8318	0.9000	0.7693	0.7834	0.9000	0.6762	0.6894
	VAR	0.2517	0.2551	0.2522	0.1314	0.1644	0.1711	0.0717	0.0912	0.1194
IN	SKEW	0.0	0.0	0.6013	0.0	0.0	0.4664	0.0	0.0	0.2293
	KURT	0.0	0.0	0.6313	0.0	0.0	0.6940	0.0	0.0	0.1388
	MEAN	0.9000	0.5312	0.6243	0.9000	0.6058	0.6130	0.9000	0.6145	0.6184
	VAR	0.2517	0.3435	0.3820	0.1314	0.1712	0.1706	0.0717	0.0915	0.0894
IN	SKEW	0.0	0.0	0.2910	0.0	0.0	0.0351	0.0	0.0	-0.0328
	KURT	0.0	0.0	3.6282	0.0	0.0	0.5498	0.0	0.0	0.0040
[illegible]R = 67										
	MEAN	0.9000	0.5216	0.6788	0.9000	0.5121	0.5294	0.9000	0.3752	0.3879
	VAR	0.2517	0.3035	0.3387	0.1314	0.1751	0.1747	0.0717	0.0375	0.1233
IN	SKEW	0.0	0.0	0.8725	0.0	0.0	0.4596	0.0	0.0	0.0938
	KURT	0.0	0.0	7.2520	0.0	0.0	1.0038	0.0	0.0	0.0721
	MEAN	0.9000	0.4107	0.4474	0.9000	0.4379	0.4493	0.9000	0.4454	0.4491
	VAR	0.2517	0.3353	0.3998	0.1314	0.1661	0.1734	0.0717	0.0903	0.0914
[illegible]	SKEW	0.0	0.0	-0.2523	0.0	0.0	0.0689	0.0	0.0	0.0293
	KURT	0.0	0.0	3.6377	0.0	0.0	0.3697	0.0	0.0	0.3384
[illegible]=100										
	MEAN	0.9000	0.44[illegible]	0.4[illegible]5[illegible]	0.9000	0.3273	0.3[illegible]07	0.9000	0.2221	0.2314
	VAR	0.2517	0.3[illegible]	0.[illegible]	0.1314	0.1536	0.1676	0.0717	0.0740	0.1081
[illegible]	SKEW	0.0	0.0	0.[illegible]13[illegible]	0.0	0.0	0.0[illegible]11	0.0	0.0	-0.0476
	KURT	0.0	0.0	11.7[illegible]	0.0	0.0	1.4218	0.0	0.0	0.2499

TABLE [illegible] SUMMARY STATISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR X VALUES RECTANGULARLY [illegible] VALUES [illegible] NORMALLY DISTRIBUTED [illegible] EVERY VALUE OF X , RANDOM AND FIXED VALUES OF [illegible] SAMPLE SIZES, [illegible], AND A VALUE [illegible] ESTIMATE BASED ON A CORRELATION [illegible] 0.0

SAMPLE SIZE

			N=5			N=13			N=33		
			EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
ERROR= 0		MEAN	0.0	-0.0010	0.0025	0.0	0.0002	0.0011	0.0	-0.0026	-0.0032
		VAR	0.5774	0.5553	0.6306	0.3015	0.2979	0.3120	0.1644	0.1642	0.1640
	RR	SKEW	0.0	0.0	0.2345	0.0	0.0	0.0381	0.0	0.0	-0.0461
		KURT	0.0	0.0	5.2497	0.0	0.0	0.4799	0.0	0.0	0.0765
		MEAN	0.0	-0.0152	-0.0235	0.0	0.0057	0.0057	0.0	-0.0025	-0.0019
		VAR	0.5774	0.5435	0.4907	0.3015	0.2543	0.2769	0.1644	0.1616	0.1588
	FR	SKEW	0.0	0.0	-0.0913	0.0	0.0	-0.0518	0.0	0.0	0.0256
		KURT	0.0	0.0	0.1162	0.0	0.0	0.0803	0.0	0.0	0.0988
ERROR= 33		MEAN	0.0	0.0133	0.0139	0.0	-0.0023	-0.0016	0.0	0.0014	0.0005
		VAR	0.5774	0.5379	0.6456	0.3015	0.2840	0.2569	0.1644	0.1556	0.1611
	RR	SKEW	0.0	0.0	-0.0666	0.0	0.0	-0.0410	0.0	0.0	-0.0656
		KURT	0.0	0.0	4.7423	0.0	0.0	0.2406	0.0	0.0	-0.1962
		MEAN	0.0	-0.0047	-0.0047	0.0	-0.0045	-0.0029	0.0	0.0021	0.0025
		VAR	0.5774	0.5185	0.5056	0.3015	0.2723	0.2629	0.1644	0.1469	0.1475
	FR	SKEW	0.0	0.0	0.0785	0.0	0.0	0.0135	0.0	0.0	0.0498
		KURT	0.0	0.0	0.5599	0.0	0.0	0.0063	0.0	0.0	0.1323
ERROR= 67		MEAN	0.0	-0.0045	-0.0053	0.0	0.0010	-0.0008	0.0	0.0012	0.0010
		VAR	0.5774	0.4778	0.5492	0.3015	0.2503	0.2616	0.1644	0.1363	0.1396
	RR	SKEW	0.0	0.0	0.0545	0.0	0.0	-0.0435	0.0	0.0	0.0479
		KURT	0.0	0.0	3.4114	0.0	0.0	0.5606	0.0	0.0	0.1637
		MEAN	0.0	0.0025	-0.0003	0.0	0.0030	0.0019	0.0	0.0019	0.0022
		VAR	0.5774	0.4646	0.5014	0.3015	0.2436	0.2495	0.1644	0.1199	0.1230
	FR	SKEW	0.0	0.0	0.1214	0.0	0.0	-0.0014	0.0	0.0	-0.0366
		KURT	0.0	0.0	3.1657	0.0	0.0	0.3886	0.0	0.0	0.2597
ERROR=100		MEAN	0.0	0.0068	0.0151	0.0	-0.0072	-0.0078	0.0	0.0025	0.0023
		VAR	0.5774	0.4071	0.4637	0.3015	0.2130	0.2233	0.1644	0.1159	0.1163
	RR	SKEW	0.0	0.0	0.1121	0.0	0.0	0.0746	0.0	0.0	0.0421
		KURT	0.0	0.0	7.0369	0.0	0.0	0.7579	0.0	0.0	-0.0377
		MEAN	0.0	0.0069	0.0019	0.0	0.0004	-0.0009	0.0	-0.0016	-0.0025
		VAR	0.5774	0.4033	0.4533	0.3015	0.2035	0.2155	0.1644	0.0959	0.1034
	[illegible]	SKEW	0.0	0.0	-0.4712	0.0	0.0	-0.1413	0.0	0.0	-0.0269
		KURT	0.0	0.0	4.1137	0.0	0.0	0.5092	0.0	0.0	0.9924

TABLE 7 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AT A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.30

SAMPLE SIZE

			N=5			N=13			N=39		
			EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
		MEAN	0.3000	0.2679	0.2995	0.3000	0.3024	0.3137	0.3000	0.2978	0.3007
		VAR	0.5508	0.5460	0.6007	0.2876	0.2821	0.2853	0.1568	0.1565	0.1558
	FR	SKEW	0.0	0.0	0.1613	0.0	0.0	-0.1122	0.0	0.0	-0.0125
		KURT	0.0	0.0	4.3944	0.0	0.0	0.5110	0.0	0.0	0.1141
ERROR= 0											
		MEAN	0.3000	0.2742	0.3068	0.3000	0.2939	0.3040	0.3000	0.3010	0.3026
		VAR	0.5508	0.5161	0.4753	0.2876	0.2733	0.2639	0.1568	0.1680	0.1523
	FR	SKEW	0.0	0.0	0.0520	0.0	0.0	0.1444	0.0	0.0	0.0222
		KURT	0.0	0.0	-0.0315	0.0	0.0	0.0490	0.0	0.0	-0.1656
		MEAN	0.3000	0.2216	0.2514	0.3000	0.2587	0.2697	0.3000	0.2671	0.2713
		VAR	0.5508	0.5068	0.6054	0.2876	0.2729	0.2751	0.1568	0.1501	0.1505
	RR	SKEW	0.0	0.0	-0.2467	0.0	0.0	0.0386	0.0	0.0	0.0913
		KURT	0.0	0.0	10.3975	0.0	0.0	0.3247	0.0	0.0	0.0885
ERROR= 33											
		MEAN	0.3000	0.2461	0.2858	0.3000	0.2614	0.2737	0.3000	0.2551	0.2599
		VAR	0.5508	0.5020	0.4768	0.2876	0.2613	0.2641	0.1568	0.1544	0.1507
	FR	SKEW	0.0	0.0	0.2139	0.0	0.0	0.0893	0.0	0.0	0.0347
		KURT	0.0	0.0	0.4467	0.0	0.0	0.2244	0.0	0.0	0.1770
		MEAN	0.3000	0.1752	0.2059	0.3000	0.2038	0.2145	0.3000	0.2070	0.2107
		VAR	0.5505	0.4552	0.5290	0.2876	0.2409	0.2519	0.1568	0.1316	0.1350
	RR	SKEW	0.0	0.0	0.2369	0.0	0.0	0.1337	0.0	0.0	-0.0186
		KURT	0.0	0.0	3.4234	0.0	0.0	0.7664	0.0	0.0	0.1101
ERROR= 67											
		MEAN	0.3000	0.2375	0.2469	0.3000	0.2125	0.2253	0.3000	0.1638	0.1683
		VAR	0.5508	0.4492	0.4574	0.2876	0.2341	0.2417	0.1568	0.1270	0.1300
	FR	SKEW	0.0	0.0	0.2227	0.0	0.0	0.1501	0.0	0.0	0.1050
		KURT	0.0	0.0	0.8334	0.0	0.0	0.2096	0.0	0.0	0.3206
		MEAN	0.3000	0.1408	0.1694	0.3000	0.1497	0.1560	0.3000	0.1454	0.1472
		VAR	0.5508	0.3930	0.4774	0.2576	0.2105	0.2146	0.1568	0.1137	0.1121
	RR	SKEW	0.0	0.0	0.4942	0.0	0.0	0.0030	0.0	0.0	0.0271
		KURT	0.0	0.0	5.6341	0.0	0.0	0.4666	0.0	0.0	-0.0637
ERROR=100											
		MEAN	0.3000	0.1537	0.168[illegible]	0.3000	0.1442	0.1523	0.3000	0.1021	0.1043
		VAR	0.5508	0.4017	0.4025	0.2876	0.2051	0.2036	0.1568	0.0956	0.0799
	FR	SKEW	0.0	0.0	0.6694	0.0	0.0	0.1010	0.0	0.0	0.1968
		KURT	0.0	0.0	[illegible].1310	0.0	0.0	0.5023	0.0	0.0	0.5524

TABLE 8 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR X VALUES RECTANGULARLY DISTRIBUTED WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X , RANDOM AND FIXED VALUES OF THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

SAMPLE SIZE

			N=5			N=13			N=39		
			EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
ERROR= 0	RR	MEAN	0.6000	0.5456	0.5395	0.6000	0.5796	0.5933	0.6000	0.5937	0.5983
		VAR	0.4619	0.4714	0.5125	0.2412	0.2415	0.2395	0.1315	0.1312	0.1336
		SKEW	0.0	0.0	-0.5311	0.0	0.0	-0.0103	0.0	0.0	-0.1183
		KURT	0.0	0.0	11.1176	0.0	0.0	0.1300	0.0	0.0	0.1384
	FR	MEAN	0.6000	0.5515	0.5925	0.6000	0.5812	0.5926	0.6000	0.6010	0.6041
		VAR	0.4619	0.4448	0.4111	0.2412	0.2276	0.2246	0.1315	0.1291	0.1273
		SKEW	0.0	0.0	0.0640	0.0	0.0	-0.0133	0.0	0.0	0.0639
		KURT	0.0	0.0	0.0048	0.0	0.0	0.2756	0.0	0.0	0.0338
ERROR= 33	RR	MEAN	0.6000	0.4969	0.5397	0.6000	0.5372	0.5517	0.6000	0.5447	0.5495
		VAR	0.4619	0.4571	0.5385	0.2412	0.2340	0.2360	0.1315	0.1282	0.1269
		SKEW	0.0	0.0	-3.3034	0.0	0.0	0.1598	0.0	0.0	0.0460
		KURT	0.0	0.0	66.0961	0.0	0.0	0.7412	0.0	0.0	0.1676
	FR	MEAN	0.6000	0.5239	0.5784	0.6000	0.5380	0.5512	0.6000	0.4989	0.5061
		VAR	0.4619	0.4238	0.4112	0.2412	0.2229	0.2192	0.1315	0.1237	0.1307
		SKEW	0.0	0.0	0.1275	0.0	0.0	0.1311	0.0	0.0	0.3083
		KURT	0.0	0.0	0.2329	0.0	0.0	0.1301	0.0	0.0	0.2981
ERROR= 67	RR	MEAN	0.6000	0.3911	0.4363	0.6000	0.4063	0.4209	0.6000	0.4153	0.4199
		VAR	0.4619	0.4119	0.4686	0.2412	0.2171	0.2186	0.1315	0.1186	0.1175
		SKEW	0.0	0.0	0.5362	0.0	0.0	0.0596	0.0	0.0	0.1572
		KURT	0.0	0.0	5.0615	0.0	0.0	0.8023	0.0	0.0	0.2314
	FR	MEAN	0.6000	0.4055	0.4602	0.6000	0.4294	0.4446	0.6000	0.3269	0.3332
		VAR	0.4619	0.4072	0.4222	0.2412	0.2095	0.2025	0.1315	0.1090	0.1123
		SKEW	0.0	0.0	0.5914	0.0	0.0	0.2562	0.0	0.0	0.1212
		KURT	0.0	0.0	2.8812	0.0	0.0	0.3852	0.0	0.0	0.4418
ERROR=100	RR	MEAN	0.6000	0.2948	0.3295	0.6000	0.2975	0.3120	0.6000	0.2953	0.2988
		VAR	0.4619	0.3723	0.4701	0.2412	0.1929	0.1973	0.1315	0.1055	0.1033
		SKEW	0.0	0.0	-3.7075	0.0	0.0	0.1675	0.0	0.0	-0.0515
		KURT	0.0	0.0	51.2427	0.0	0.0	0.5117	0.0	0.0	0.1170
	FR	MEAN	0.6000	0.2734	0.3345	0.6000	0.3076	0.3183	0.6000	0.2101	0.2137
		VAR	0.4619	0.3694	0.3880	0.2412	0.1884	0.1802	0.1315	0.0901	0.0980
		SKEW	0.0	0.0	0.5338	0.0	0.0	0.2339	0.0	0.0	-0.0175
		KURT	0.0	0.0	5.5214	0.0	0.0	0.5044	0.0	0.0	0.3156

TABLE [illegible] SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF SLOPE FOR X VALUES RECTANGULARLY DISTRIBUTED WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF THE SAMPLE SIZE N, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.90

SAMPLE SIZE

ERROR			N=5 EXPECT T	N=5 EXPECT O	N=5 OBSERVED	N=13 EXPECT T	N=13 EXPECT O	N=13 OBSERVED	N=39 EXPECT T	N=39 EXPECT O	N=39 OBSERVED
ERR= 0	RR	MEAN	0.9000	0.8713	0.8954	0.9000	0.8912	0.8956	0.9000	0.8973	0.8985
		VAR	0.2517	0.2649	0.2794	0.1314	0.1323	0.1310	0.0717	0.0717	0.0729
		SKEW	0.0	0.0	0.2711	0.0	0.0	-0.0472	0.0	0.0	-0.0852
		KURT	0.0	0.0	12.2902	0.0	0.0	0.4308	0.0	0.0	0.0004
	FR	MEAN	0.9000	0.9020	0.9062	0.9000	0.8998	0.9009	0.9000	0.8976	0.8980
		VAR	0.2517	0.2272	0.2181	0.1314	0.1228	0.1218	0.0717	0.0701	0.0693
		SKEW	0.0	0.0	0.0353	0.0	0.0	-0.0216	0.0	0.0	-0.0113
		KURT	0.0	0.0	0.0151	0.0	0.0	-0.0069	0.0	0.0	-0.0317
ERR= 33	RR	MEAN	0.9000	0.7345	0.8177	0.9000	0.8078	0.8160	0.9000	0.8113	0.8137
		VAR	0.2517	0.3007	0.3227	0.1314	0.1474	0.1450	0.0717	0.0809	0.0799
		SKEW	0.0	0.0	-0.0949	0.0	0.0	0.1183	0.0	0.0	0.0654
		KURT	0.0	0.0	5.2204	0.0	0.0	0.4174	0.0	0.0	-0.0315
	FR	MEAN	0.9000	0.8243	0.8490	0.9000	0.8134	0.8264	0.9000	0.7545	0.7618
		VAR	0.2517	0.2597	0.2596	0.1314	0.1337	0.1368	0.0717	0.0846	0.0990
		SKEW	0.0	0.0	0.6164	0.0	0.0	0.1669	0.0	0.0	0.4896
		KURT	0.0	0.0	1.4000	0.0	0.0	0.2196	0.0	0.0	0.4881
ERR= 67	RR	MEAN	0.9000	0.6044	0.6392	0.9000	0.6177	0.6303	0.9000	0.6191	0.6229
		VAR	0.2517	0.3292	0.3911	0.1314	0.1652	0.1572	0.0717	0.0907	0.0860
		SKEW	0.0	0.0	-1.5493	0.0	0.0	0.3015	0.0	0.0	0.2088
		KURT	0.0	0.0	23.3747	0.0	0.0	0.7258	0.0	0.0	0.1993
	FR	MEAN	0.9000	0.6592	0.7060	0.9000	0.6507	0.6641	0.9000	0.4937	0.5013
		VAR	0.2517	0.3054	0.3090	0.1314	0.1611	0.1456	0.0717	0.0902	0.0985
		SKEW	0.0	0.0	1.0129	0.0	0.0	0.6010	0.0	0.0	0.2160
		KURT	0.0	0.0	7.2398	0.0	0.0	0.8191	0.0	0.0	0.4362
ERR=100	RR	MEAN	0.9000	0.4363	0.4760	0.9000	0.4516	0.4623	0.9000	0.4507	0.4538
		VAR	0.2517	0.3255	0.3761	0.1314	0.1657	0.1559	0.0717	0.0900	0.0806
		SKEW	0.0	0.0	1.1926	0.0	0.0	0.1154	0.0	0.0	0.0131
		KURT	0.0	0.0	12.2619	0.0	0.0	0.8125	0.0	0.0	0.2449
	FR	MEAN	0.9000	0.4632	0.4931	0.9000	0.4742	0.4842	0.9000	0.3141	0.3174
		VAR	0.2517	0.3269	0.3497	0.1314	0.1625	0.1387	0.0717	0.0825	0.0957
		SKEW	0.0	0.0	0.1520	0.0	0.0	0.3364	0.0	0.0	-0.2581
		KURT	0.0	0.0	8.1909	0.0	0.0	0.7289	0.0	0.0	0.9491

TABLE 10. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTIONS OF INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.0

SAMPLE SIZE

			N=5			N=13			N=39		
			EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
ERROR = 0	RN	MEAN	50.0000	50.4481	49.9050	50.0000	48.3934	48.9327	50.0000	50.0618	49.9521
		VAR	20.1556	20.1261	21.9487	10.8333	10.3300	11.3960	5.9254	5.9003	6.0610
		SKEW	0.0	0.0	-0.1732	0.0	0.0	0.0570	0.0	0.0	-0.0732
		KURT	0.0	0.0	1.5999	0.0	0.0	0.0994	0.0	0.0	-0.0341
	FN	MEAN	50.0000	49.1932	49.1635	50.0000	50.2839	50.2492	50.0000	50.0511	50.0422
		VAR	20.1556	18.2015	17.9099	10.8333	11.3309	11.3150	5.9254	6.0779	6.0725
		SKEW	0.0	0.0	0.0951	0.0	0.0	-0.0122	0.0	0.0	0.0665
		KURT	0.0	0.0	-0.0651	0.0	0.0	0.2366	0.0	0.0	0.0941
ERROR = 33	RN	MEAN	50.0000	50.6097	50.1752	50.0000	49.0038	49.0365	50.0000	50.0987	50.0813
		VAR	20.1556	19.0422	19.9734	10.8333	10.3103	11.0422	5.9254	5.6219	5.6414
		SKEW	0.0	0.0	-0.2951	0.0	0.0	0.1118	0.0	0.0	-0.0075
		KURT	0.0	0.0	1.7296	0.0	0.0	0.3197	0.0	0.0	0.1415
	FN	MEAN	50.0000	49.4599	49.5221	50.0000	50.4611	50.5580	50.0000	49.9445	50.0436
		VAR	20.1556	18.2755	17.1612	10.8333	10.9407	10.6450	5.9254	5.3554	5.5605
		SKEW	0.0	0.0	-0.0513	0.0	0.0	0.2051	0.0	0.0	-0.0600
		KURT	0.0	0.0	0.6300	0.0	0.0	0.3556	0.0	0.0	-0.0304
ERROR = 67	RN	MEAN	50.0000	50.8335	50.9179	50.0000	49.5761	49.5606	50.0000	50.1304	50.1577
		VAR	20.1556	14.8057	17.6979	10.8333	9.1170	9.3149	5.9254	4.9397	4.8414
		SKEW	0.0	0.0	-0.1336	0.0	0.0	-0.0755	0.0	0.0	-0.1257
		KURT	0.0	0.0	1.3360	0.0	0.0	0.3904	0.0	0.0	0.1380
	FN	MEAN	50.0000	48.9814	49.3670	50.0000	49.7255	49.8506	50.0000	50.2435	50.2199
		VAR	20.1556	15.7496	15.8407	10.8333	9.1253	9.8351	5.9254	4.0666	5.6926
		SKEW	0.0	0.0	0.1752	0.0	0.0	0.0372	0.0	0.0	0.0467
		KURT	0.0	0.0	0.2796	0.0	0.0	0.2615	0.0	0.0	0.1521
ERROR = 100	RN	MEAN	50.0000	50.8533	50.6973	50.0000	49.6951	49.9107	50.0000	49.9149	49.9664
		VAR	20.1556	14.3198	16.1592	10.8333	7.7554	8.2363	5.9254	4.2514	4.4823
		SKEW	0.0	0.0	0.2547	0.0	0.0	-0.0107	0.0	0.0	-0.1001
		KURT	0.0	0.0	1.5536	0.0	0.0	0.0497	0.0	0.0	0.1677
	FN	MEAN	50.0000	50.1312	50.3463	50.0000	49.9073	49.8437	50.0000	49.9309	49.3047
		VAR	20.1556	13.5911	15.5547	10.8333	7.4078	8.1050	5.9254	3.1750	6.7315
		SKEW	0.0	0.0	0.0927	0.0	0.0	0.0293	0.0	0.0	-0.0402
		KURT	0.0	0.0	0.5003	0.0	0.0	0.3100	0.0	0.0	-0.0242

TABLE 11 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.30

SAMPLE SIZE

			N=5			N=13			N=39		
			EXPECT T	EXPECT Q	OBSERVED	EXPECT T	EXPECT Q	OBSERVED	EXPECT T	EXPECT Q	OBSERVED
		MEAN	35.0000	34.0461	33.7203	35.0000	34.5459	34.4748	35.0000	34.8728	34.9663
		VAR	19.2273	19.4547	20.3450	10.3343	10.4131	10.5761	5.6525	5.6758	5.8795
	RN	SKEW	0.0	0.0	-0.0227	0.0	0.0	-0.1135	0.0	0.0	0.0754
		KURT	0.0	0.0	1.2739	0.0	0.0	0.2979	0.0	0.0	-0.0541
ERROR = 0											
		MEAN	35.0000	35.4477	35.5707	35.0000	35.3324	35.2576	35.0000	35.1564	35.1352
		VAR	19.2273	18.0299	16.5833	10.3343	11.2150	10.9759	5.6525	5.8385	5.6478
	FN	SKEW	0.0	0.0	-0.0405	0.0	0.0	0.0192	0.0	0.0	0.0132
		KURT	0.0	0.0	-0.1218	0.0	0.0	0.1704	0.0	0.0	-0.0265
		MEAN	35.0000	36.2631	36.8658	35.0000	36.4326	36.6256	35.0000	36.4364	36.5421
		VAR	19.2273	18.6408	18.4969	10.3343	9.9774	9.8226	5.6525	5.4031	5.6687
	RN	SKEW	0.0	0.0	0.1479	0.0	0.0	0.1009	0.0	0.0	-0.1328
		KURT	0.0	0.0	0.9250	0.0	0.0	0.2977	0.0	0.0	-0.0020
ERROR = 33											
		MEAN	35.0000	36.3917	36.8996	35.0000	36.7585	36.8648	35.0000	38.6374	38.9555
		VAR	19.2273	17.2573	16.3065	10.3343	10.6210	10.7272	5.6525	5.1672	5.6700
	FN	SKEW	0.0	0.0	0.0599	0.0	0.0	-0.0203	0.0	0.0	-0.0151
		KURT	0.0	0.0	-0.0874	0.0	0.0	0.0467	0.0	0.0	0.0436
		MEAN	35.0000	39.4565	39.9983	35.0000	39.6128	39.6266	35.0000	39.4946	39.4931
		VAR	19.2273	16.6960	17.1802	10.3343	8.3824	9.1452	5.6525	4.8081	4.9300
	RN	SKEW	0.0	0.0	0.0142	0.0	0.0	-0.0440	0.0	0.0	-0.1098
		KURT	0.0	0.0	1.5557	0.0	0.0	0.1795	0.0	0.0	-0.1008
ERROR = 67											
		MEAN	35.0000	38.8104	39.4383	35.0000	40.6465	41.0824	35.0000	43.4441	43.6814
		VAR	19.2273	15.5644	15.9439	10.3343	8.3146	9.1660	5.6525	3.9782	5.7022
	FN	SKEW	0.0	0.0	-0.4380	0.0	0.0	-0.0093	0.0	0.0	-0.0874
		KURT	0.0	0.0	0.8924	0.0	0.0	0.1707	0.0	0.0	-0.0390
		MEAN	35.0000	43.0368	42.8449	35.0000	42.6179	42.6512	35.0000	42.3750	42.4181
		VAR	19.2273	13.7378	15.7186	10.3343	7.5974	8.4607	5.6525	4.2083	4.6399
	RN	SKEW	0.0	0.0	0.0081	0.0	0.0	0.1301	0.0	0.0	-0.0593
		KURT	0.0	0.0	1.5126	0.0	0.0	0.1241	0.0	0.0	-0.0013
ERROR=100											
		MEAN	35.0000	42.7631	42.1953	35.0000	43.9850	43.9987	35.0000	46.1013	46.2043
		VAR	19.2273	13.6337	15.6959	10.3343	7.3820	8.5186	5.6525	3.1415	6.7214
	FN	SKEW	0.0	0.0	-0.1241	0.0	0.0	-0.0648	0.0	0.0	0.0453
		KURT	0.0	0.0	0.3189	0.0	0.0	0.3419	0.0	0.0	0.0155

TABLE 12 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTIONS OF INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

SAMPLE SIZE

			N=5			N=13			N=37		
			EXPECT T	EXPECT Q	OBSERVED	EXPECT T	EXPECT Q	OBSERVED	EXPECT T	EXPECT Q	OBSERVED
		MEAN	20.0000	20.0034	19.6697	20.0000	19.8367	19.9969	20.0000	19.9733	19.9448
		VAR	16.1245	17.0025	17.0883	8.6667	8.8971	8.8739	4.7403	4.7967	4.7978
	RN	SKEW	0.0	0.0	-0.2179	0.0	0.0	-0.0022	0.0	0.0	0.0164
		KURT	0.0	0.0	1.5062	0.0	0.0	0.4522	0.0	0.0	-0.0302
ERROR= 0											
		MEAN	20.0000	19.6179	19.6130	20.0000	20.4023	20.5175	20.0000	20.1757	20.1192
		VAR	16.1245	15.4239	14.0903	8.6667	9.5614	9.2235	4.7403	4.9029	4.8374
	FN	SKEW	0.0	0.0	-0.0823	0.0	0.0	-0.0766	0.0	0.0	0.0066
		KURT	0.0	0.0	-0.1320	0.0	0.0	0.0144	0.0	0.0	0.0599
		MEAN	20.0000	23.4199	23.4874	20.0000	22.6093	22.5590	20.0000	22.8489	22.9106
		VAR	16.1245	16.2421	15.5696	8.6667	8.6641	8.7138	4.7403	4.6652	4.7266
	RN	SKEW	0.0	0.0	0.1033	0.0	0.0	-0.1289	0.0	0.0	-0.0233
		KURT	0.0	0.0	1.1206	0.0	0.0	0.3638	0.0	0.0	-0.1247
ERROR= 33											
		MEAN	20.0000	22.2593	22.6871	20.0000	24.1920	24.6259	20.0000	27.2258	27.4992
		VAR	16.1245	14.8841	13.9714	8.6667	9.1010	9.0914	4.7403	4.5207	5.0165
	FN	SKEW	0.0	0.0	-0.1580	0.0	0.0	-0.1796	0.0	0.0	-0.0679
		KURT	0.0	0.0	0.0676	0.0	0.0	-0.1464	0.0	0.0	0.0344
		MEAN	20.0000	28.9234	29.1621	20.0000	29.7257	29.8089	20.0000	29.4946	29.4073
		VAR	16.1245	15.0772	15.5470	8.6667	8.0039	8.2217	4.7403	4.3064	4.4222
	RN	SKEW	0.0	0.0	0.5284	0.0	0.0	0.0873	0.0	0.0	-0.1130
		KURT	0.0	0.0	2.4131	0.0	0.0	0.0001	0.0	0.0	0.0387
ERROR= 67											
		MEAN	20.0000	27.3720	29.0995	20.0000	32.2036	32.8539	20.0000	36.8686	37.1055
		VAR	16.1245	13.9472	15.0097	8.6667	8.0251	8.3593	4.7403	3.7344	5.7096
	FN	SKEW	0.0	0.0	-0.3627	0.0	0.0	-0.2390	0.0	0.0	0.0231
		KURT	0.0	0.0	1.1697	0.0	0.0	0.1610	0.0	0.0	-0.0919
		MEAN	20.0000	34.4340	34.6446	20.0000	35.0654	35.2079	20.0000	34.9207	34.9515
		VAR	16.1245	13.4755	14.4894	8.6667	7.1444	7.7479	4.7403	3.8915	4.3054
	RN	SKEW	0.0	0.0	0.1528	0.0	0.0	0.1300	0.0	0.0	-0.0096
		KURT	0.0	0.0	0.8692	0.0	0.0	0.1110	0.0	0.0	0.3072
ERROR=100											
		MEAN	20.0000	33.8851	34.8646	20.0000	38.7479	38.9860	20.0000	42.4165	42.8144
		VAR	16.1245	12.4443	14.2316	8.6667	6.7933	7.8290	4.7403	3.0214	6.8465
	FN	SKEW	0.0	0.0	-0.0129	0.0	0.0	-0.1640	0.0	0.0	0.0521
		KURT	0.0	0.0	0.3030	0.0	0.0	0.5152	0.0	0.0	0.0133

TABLE 13 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.90

SAMPLE SIZE

			N=5			N=13			N=39		
			EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
ERROR= 0	RN	MEAN	5.0000	4.9176	5.3107	5.0000	4.9544	5.0002	5.0000	5.0347	5.0280
		VAR	8.7556	9.8212	9.1562	4.7221	4.3711	4.9714	2.5828	2.6025	2.6401
		SKEW	0.0	0.0	0.1679	0.0	0.0	-0.0733	0.0	0.0	0.0276
		KURT	0.0	0.0	2.0527	0.0	0.0	0.0942	0.0	0.0	0.1256
	FN	MEAN	5.0000	4.5347	4.5419	5.0000	5.0133	4.9468	5.0000	5.0046	4.9469
		VAR	8.7556	7.8482	7.8125	4.7221	5.1067	4.9437	2.5828	2.6495	2.6546
		SKEW	0.0	0.0	-0.1534	0.0	0.0	-0.0635	0.0	0.0	0.0771
		KURT	0.0	0.0	0.0711	0.0	0.0	-0.1140	0.0	0.0	-0.1792
ERROR= 33	RN	MEAN	5.0000	5.5415	5.2584	5.0000	9.4868	9.5068	5.0000	9.3746	9.4206
		VAR	8.7556	10.1382	9.1259	4.7221	5.5547	5.4550	2.5828	2.9428	3.0026
		SKEW	0.0	0.0	0.2674	0.0	0.0	-0.0421	0.0	0.0	-0.0660
		KURT	0.0	0.0	1.7536	0.0	0.0	0.1977	0.0	0.0	0.2533
	FN	MEAN	5.0000	8.3973	9.6209	5.0000	10.8559	11.4514	5.0000	15.5527	16.0176
		VAR	8.7556	8.9619	9.2088	4.7221	5.8981	6.0095	2.5828	3.2959	4.6763
		SKEW	0.0	0.0	-0.2943	0.0	0.0	-0.3973	0.0	0.0	-0.0690
		KURT	0.0	0.0	0.1566	0.0	0.0	0.4048	0.0	0.0	-0.0056
ERROR= 67	RN	MEAN	5.0000	13.7141	18.0959	5.0000	19.1323	19.1801	5.0000	19.0939	19.1251
		VAR	8.7556	12.0436	11.7561	4.7221	6.2005	6.3003	2.5828	3.3284	3.3276
		SKEW	0.0	0.0	0.1820	0.0	0.0	0.1002	0.0	0.0	-0.0483
		KURT	0.0	0.0	1.2893	0.0	0.0	0.1707	0.0	0.0	-0.0490
	FN	MEAN	5.0000	16.1528	13.4635	5.0000	23.5831	24.2166	5.0000	30.6148	31.2150
		VAR	8.7556	10.3412	11.3235	4.7221	6.3278	6.4923	2.5828	3.2272	6.0181
		SKEW	0.0	0.0	-0.4441	0.0	0.0	-0.1902	0.0	0.0	0.0409
		KURT	0.0	0.0	0.9772	0.0	0.0	0.0814	0.0	0.0	0.0621
ERROR=100	RN	MEAN	5.0000	27.4674	27.2419	5.0000	27.4984	27.5922	5.0000	27.5321	27.6139
		VAR	8.7556	11.3436	12.4505	4.7221	6.0926	6.5412	2.5828	3.3229	3.7015
		SKEW	0.0	0.0	0.1070	0.0	0.0	-0.1144	0.0	0.0	-0.0508
		KURT	0.0	0.0	0.6301	0.0	0.0	-0.0856	0.0	0.0	0.1773
	FN	MEAN	5.0000	25.2910	27.3282	5.0000	33.0360	33.4434	5.0000	33.4703	38.6870
		VAR	8.7556	10.9134	12.6093	4.7221	5.8057	6.9934	2.5823	2.7947	7.1033
		SKEW	0.0	0.0	-0.0144	0.0	0.0	0.1130	0.0	0.0	0.1313
		KURT	0.0	0.0	0.5033	0.0	0.0	0.1205	0.0	0.0	-0.1660

TABLE 14. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.0

SAMPLE SIZE

			N=5			N=13			N=39		
			EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
		MEAN	50.0000	49.9010	50.2251	50.0000	50.0326	50.0130	50.0000	50.1996	50.1497
		VAR	20.1556	19.3935	19.2532	10.8333	10.7002	11.2463	5.9254	5.9160	6.0236
	RR	SKEW	0.0	0.0	-0.0166	0.0	0.0	-0.1305	0.0	0.0	0.0936
		KURT	0.0	0.0	0.0017	0.0	0.0	0.0321	0.0	0.0	0.1327
ERROR= 0											
		MEAN	50.0000	51.2472	51.1547	50.0000	49.7994	49.7130	50.0000	50.0766	50.0943
		VAR	20.1556	13.9731	17.6760	10.8333	10.2307	9.7614	5.9254	5.8262	5.5358
	FR	SKEW	0.0	0.0	0.0997	0.0	0.0	-0.0689	0.0	0.0	-0.1605
		KURT	0.0	0.0	0.0282	0.0	0.0	-0.2389	0.0	0.0	-0.0191
		MEAN	50.0000	49.3[illegible]41	49.3301	50.0000	50.1457	50.1534	50.0000	50.0068	49.9344
		VAR	20.1556	18.8023	19.6545	10.8333	10.2352	10.3976	5.9254	5.6172	5.8977
	RR	SKEW	0.0	0.0	0.0072	0.0	0.0	0.0003	0.0	0.0	-0.0018
		KURT	0.0	0.0	1.1515	0.0	0.0	0.5205	0.0	0.0	-0.2414
ERROR= 33											
		MEAN	50.0000	50.2344	50.2554	50.0000	50.1304	50.1745	50.0000	49.9423	49.8893
		VAR	20.1556	18.1303	17.3502	10.8333	9.8135	9.2545	5.9254	5.3184	5.3959
	FR	SKEW	0.0	0.0	0.0647	0.0	0.0	0.0484	0.0	0.0	-0.0189
		KURT	0.0	0.0	0.3522	0.0	0.0	0.0459	0.0	0.0	-0.1634
		MEAN	50.0000	50.2867	50.2612	50.0000	49.9795	49.9432	50.0000	49.9242	49.9749
		VAR	20.1556	16.7346	17.6345	10.8333	9.0608	9.5746	5.9254	4.9582	5.3141
	RR	SKEW	0.0	0.0	0.0043	0.0	0.0	-0.0164	0.0	0.0	-0.0584
		KURT	0.0	0.0	0.6721	0.0	0.0	0.4370	0.0	0.0	-0.1306
ERROR= 67											
		MEAN	50.0000	49.3530	49.5433	50.0000	49.9726	49.8322	50.0000	49.8680	49.8351
		VAR	20.1556	16.3171	16.8972	10.8333	8.3172	8.6681	5.9254	4.3373	4.7940
	FR	SKEW	0.0	0.0	-0.1547	0.0	0.0	0.0394	0.0	0.0	0.0787
		KURT	0.0	0.0	0.7341	0.0	0.0	0.2460	0.0	0.0	0.1380
		MEAN	50.0000	49.2134	49.6186	50.0000	50.4241	50.2885	50.0000	49.8623	49.8753
		VAR	20.1556	14.4375	15.4510	10.8333	7.7724	8.4280	5.9254	4.2562	4.5171
	RR	SKEW	0.0	0.0	-0.0565	0.0	0.0	0.0068	0.0	0.0	0.0275
		KURT	0.0	0.0	0.7684	0.0	0.0	0.1373	0.0	0.0	-0.1014
ERROR=100											
		MEAN	50.0000	49.[illegible]56	49.5042	50.0000	50.0600	49.9771	50.0000	50.1102	50.1583
		VAR	20.1556	14.2[illegible]38	15.0565	10.8333	7.6546	7.7559	5.9254	3.5332	4.8963
	FR	SKEW	0.0	0.0	0.1006	0.0	0.0	0.1030	0.0	0.0	-0.2013
		KURT	0.0	0.0	1.5712	0.0	0.0	-0.0325	0.0	0.0	0.0090

TABLE 1D. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.30

SAMPLE SIZE

			N=6			N=13			N=39		
			EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED	EXPECT T	EXPECT O	OBSERVED
ERROR= 0	RR	MEAN	35.0000	35.0171	35.2023	35.0000	34.2485	34.5034	35.0000	34.9744	34.9104
		VAR	19.2273	19.0405	19.2579	10.3343	10.1552	10.0395	5.6525	5.6393	5.6555
		SKEW	0.0	0.0	0.1013	0.0	0.0	0.0234	0.0	0.0	-0.0770
		KURT	0.0	0.0	0.7373	0.0	0.0	0.1478	0.0	0.0	0.1619
	FR	MEAN	35.0000	34.5775	34.7164	35.0000	34.7822	34.7980	35.0000	33.7343	35.2101
		VAR	19.2273	18.0151	16.4912	10.3343	9.8356	9.0236	5.6525	6.0568	5.3464
		SKEW	0.0	0.0	-0.1246	0.0	0.0	-0.1439	0.0	0.0	-0.0501
		KURT	0.0	0.0	0.3506	0.0	0.0	0.0354	0.0	0.0	-0.0286
ERROR= 33	RR	MEAN	35.0000	37.3405	37.6268	35.0000	36.5047	36.6785	35.0000	36.3937	36.4449
		VAR	19.2273	17.7098	17.4586	10.3343	9.8539	9.9703	5.6525	5.4197	5.4278
		SKEW	0.0	0.0	0.0469	0.0	0.0	0.1206	0.0	0.0	-0.0632
		KURT	0.0	0.0	0.3108	0.0	0.0	0.3156	0.0	0.0	-0.1440
	FR	MEAN	35.0000	35.5914	36.0856	35.0000	36.3057	36.4446	35.0000	35.7906	37.4361
		VAR	19.2273	17.5611	16.3531	10.3343	9.4242	9.4141	5.6525	5.5361	5.1893
		SKEW	0.0	0.0	-0.0329	0.0	0.0	-0.1610	0.0	0.0	0.0073
		KURT	0.0	0.0	0.2007	0.0	0.0	0.0516	0.0	0.0	0.1450
ERROR= 67	RR	MEAN	35.0000	39.5697	39.5630	35.0000	39.3018	39.4126	35.0000	39.4916	39.4638
		VAR	19.2273	15.2525	17.0347	10.3343	9.7210	9.2299	5.6525	4.7813	5.1342
		SKEW	0.0	0.0	-0.0129	0.0	0.0	-0.0498	0.0	0.0	-0.1203
		KURT	0.0	0.0	0.4330	0.0	0.0	0.1927	0.0	0.0	0.1739
	FR	MEAN	35.0000	37.6942	38.2571	35.0000	38.3259	38.9604	35.0000	40.4159	42.0196
		VAR	19.2273	15.7957	15.5933	10.3343	8.4946	8.5948	5.6525	4.6575	4.9980
		SKEW	0.0	0.0	-0.0614	0.0	0.0	-0.0735	0.0	0.0	-0.0518
		KURT	0.0	0.0	0.3320	0.0	0.0	-0.0664	0.0	0.0	0.1123
ERROR=100	RR	MEAN	35.0000	41.5670	42.1722	35.0000	42.2341	42.1324	35.0000	42.6532	42.7121
		VAR	19.2273	14.1555	15.0336	10.3343	7.6827	8.3229	5.6525	4.1301	4.4398
		SKEW	0.0	0.0	-0.1508	0.0	0.0	-0.0250	0.0	0.0	0.0018
		KURT	0.0	0.0	1.5408	0.0	0.0	-0.0509	0.0	0.0	-0.1722
	FR	MEAN	35.0000	40.5317	41.3334	35.0000	42.4485	42.4303	35.0000	44.7901	44.6841
		VAR	19.2273	14.2255	14.4059	10.3343	7.5216	7.6266	5.6525	3.5599	4.9437
		SKEW	0.0	0.0	-0.2847	0.0	0.0	-0.0690	0.0	0.0	-0.0730
		KURT	0.0	0.0	1.3918	0.0	0.0	-0.0356	0.0	0.0	0.1568

TABLE 1[illegible]. SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF X, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

SAMPLE SIZE

ERROR			N=5 EXPECT T	N=5 EXPECT O	N=5 OBSERVED	N=13 EXPECT T	N=13 EXPECT O	N=13 OBSERVED	N=33 EXPECT T	N=33 EXPECT O	N=33 OBSERVED
0	RR	MEAN	20.0000	20.5829	20.4413	20.0000	20.3314	20.2202	20.0000	20.0828	20.0923
		VAR	16.1245	16.4259	15.7841	8.6667	8.6719	8.6976	4.7403	4.7326	4.8659
		SKEW	0.0	0.0	-0.0260	0.0	0.0	0.0	0.0	0.0	0.1410
		KURT	0.0	0.0	0.0733	0.0	0.0	0.1729	0.0	0.0	-0.0736
	FR	MEAN	20.0000	20.4032	20.3121	20.0000	20.3447	20.3873	20.0000	19.8049	19.7895
		VAR	16.1245	15.5277	14.9172	8.6667	8.1900	8.1417	4.7403	4.6573	4.6359
		SKEW	0.0	0.0	0.0531	0.0	0.0	-0.0927	0.0	0.0	-0.0443
		KURT	0.0	0.0	0.0942	0.0	0.0	-0.1292	0.0	0.0	0.1587
33	RR	MEAN	20.0000	23.0342	22.9859	20.0000	22.3857	22.6666	20.0000	22.5374	22.5794
		VAR	16.1245	16.0132	15.4723	8.6667	8.4237	8.3028	4.7403	4.6332	4.6545
		SKEW	0.0	0.0	-0.0895	0.0	0.0	0.0142	0.0	0.0	-0.0484
		KURT	0.0	0.0	0.9905	0.0	0.0	0.0969	0.0	0.0	-0.0463
	FR	MEAN	20.0000	21.1337	21.8544	20.0000	22.5329	22.5724	20.0000	24.7094	24.9121
		VAR	16.1245	14.9965	14.1477	8.6667	8.0393	7.7491	4.7403	4.4789	4.7499
		SKEW	0.0	0.0	-0.1277	0.0	0.0	-0.1812	0.0	0.0	-0.2489
		KURT	0.0	0.0	0.2520	0.0	0.0	0.1999	0.0	0.0	0.1529
67	RR	MEAN	20.0000	23.1553	28.8534	20.0000	28.9404	29.1675	20.0000	29.0402	29.0502
		VAR	16.1245	14.4508	15.0649	8.6667	7.8437	7.7483	4.7403	4.3084	4.3040
		SKEW	0.0	0.0	-0.1113	0.0	0.0	0.0264	0.0	0.0	-0.0029
		KURT	0.0	0.0	1.5513	0.0	0.0	0.4501	0.0	0.0	0.0259
	FR	MEAN	20.0000	27.0594	23.2771	20.0000	27.7259	28.2338	20.0000	33.3234	33.5467
		VAR	16.1245	14.3050	13.8385	8.6667	7.5038	7.1050	4.7403	3.9386	4.5727
		SKEW	0.0	0.0	-0.4575	0.0	0.0	-0.1227	0.0	0.0	-0.1814
		KURT	0.0	0.0	0.9922	0.0	0.0	0.0233	0.0	0.0	0.2506
100	RR	MEAN	20.0000	33.5247	33.7338	20.0000	34.4260	34.6342	20.0000	35.0505	35.0338
		VAR	16.1245	13.1564	15.5691	8.6667	7.0431	7.5383	4.7403	3.8590	4.1183
		SKEW	0.0	0.0	-0.1306	0.0	0.0	0.0015	0.0	0.0	0.0565
		KURT	0.0	0.0	0.9789	0.0	0.0	0.1269	0.0	0.0	-0.0726
	FR	MEAN	20.0000	33.2306	34.1165	20.0000	33.0819	34.4238	20.0000	39.3252	39.3197
		VAR	16.1245	13.0791	12.7287	8.6667	6.8977	6.5846	4.7403	3.3556	4.7547
		SKEW	0.0	0.0	-0.2565	0.0	0.0	-0.1538	0.0	0.0	-0.0376
		KURT	0.0	0.0	1.1945	0.0	0.0	0.4099	0.0	0.0	0.0253

TABLE 17 SOME CHARACTERISTICS OF THE SAMPLING DISTRIBUTION OF INTERCEPTS FOR X VALUES RECTANGULARLY DISTRIBUTED WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY Y VALUE OF X, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.00

SAMPLE SIZE

			N=5			N=13			N=39		
			EXPECT T	EXPECT U	OBSERVED	EXPECT T	EXPECT U	OBSERVED	EXPECT T	EXPECT U	OBSERVED
		MEAN	5.0000	5.1997	5.4656	5.0000	5.2087	5.2482	5.0000	5.0601	5.0914
		VAR	8.7856	9.2221	8.4980	4.7221	4.7595	4.3267	2.5828	2.5827	2.5995
	RR	SKEW	0.0	0.0	0.0506	0.0	0.0	0.0493	0.0	0.0	0.0522
		KURT	0.0	0.0	0.6001	0.0	0.0	0.2165	0.0	0.0	-0.0931
ERROR= 0											
		MEAN	5.0000	4.7164	4.6774	5.0000	4.9319	4.9812	5.0000	5.1108	5.0873
		VAR	8.7856	7.9304	8.0321	4.7221	4.4196	4.4217	2.5828	2.5274	2.5479
	FR	SKEW	0.0	0.0	-0.1580	0.0	0.0	0.0288	0.0	0.0	-0.0175
		KURT	0.0	0.0	0.0781	0.0	0.0	-0.2499	0.0	0.0	0.1027
		MEAN	5.0000	9.1217	9.4853	5.0000	9.1770	9.3720	5.0000	9.3229	9.3188
		VAR	8.7856	10.5217	9.7634	4.7221	5.3048	5.0345	2.5828	2.9173	2.9995
	RR	SKEW	0.0	0.0	0.0425	0.0	0.0	-0.2131	0.0	0.0	-0.1360
		KURT	0.0	0.0	0.5389	0.0	0.0	0.3552	0.0	0.0	0.1688
ERROR= 33											
		MEAN	5.0000	7.4582	8.6013	5.0000	8.6324	8.9866	5.0000	11.9083	12.2650
		VAR	8.7856	9.0970	9.1411	4.7221	4.9992	5.0078	2.5828	3.0635	3.6573
	FR	SKEW	0.0	0.0	-0.2877	0.0	0.0	-0.0807	0.0	0.0	-0.3092
		KURT	0.0	0.0	0.2211	0.0	0.0	-0.0439	0.0	0.0	0.2384
		MEAN	5.0000	18.0602	17.9802	5.0000	18.4544	18.8774	5.0000	18.3665	18.9684
		VAR	8.7856	11.5499	10.9439	4.7221	5.9840	5.8170	2.5828	3.2982	3.3254
	RR	SKEW	0.0	0.0	-0.1210	0.0	0.0	-0.0365	0.0	0.0	-0.0643
		KURT	0.0	0.0	1.0567	0.0	0.0	-0.0356	0.0	0.0	0.0040
ERROR= 67											
		MEAN	5.0000	14.7053	16.6703	5.0000	16.8174	17.4123	5.0000	24.9906	25.1947
		VAR	8.7856	10.7371	10.0950	4.7221	5.8416	5.2838	2.5828	3.2996	4.0109
	FR	SKEW	0.0	0.0	-0.6775	0.0	0.0	-0.2119	0.0	0.0	-0.1303
		KURT	0.0	0.0	1.4015	0.0	0.0	0.3272	0.0	0.0	0.0628
		MEAN	5.0000	25.1537	25.9659	5.0000	26.8392	27.0535	5.0000	27.3281	27.3530
		VAR	8.7856	11.5456	11.9180	4.7221	6.0304	6.1756	2.5828	3.3024	3.3516
	RR	SKEW	0.0	0.0	-0.0887	0.0	0.0	-0.0029	0.0	0.0	0.0706
		KURT	0.0	0.0	1.0402	0.0	0.0	0.3141	0.0	0.0	0.0175
ERROR=100											
		MEAN	5.0000	25.4134	25.6484	5.0000	25.7302	26.2514	5.0000	34.1263	34.2668
		VAR	8.7856	11.5762	10.6081	4.7221	5.9598	5.5077	2.5828	3.0300	4.6934
	FR	SKEW	0.0	0.0	-0.3219	0.0	0.0	-0.3487	0.0	0.0	0.0427
		KURT	0.0	0.0	1.2146	0.0	0.0	0.5193	0.0	0.0	-0.1051

TABLE 13 SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.0

SAMPLE SIZE

			N=5 EXPECTED	N=5 OBSERVED	N=13 EXPECTED	N=13 OBSERVED	N=39 EXPECTED	N=39 OBSERVED
ERROR= 0	RN	SLOPE-MEAN F	1.5000	1.4266	1.1000	1.1193	1.0278	1.0380
		SLOPE-I ERROR	50/ 10	47/ 9	50/ 10	52/ 15	50/ 10	53/ 14
		INTERCEPT-MEAN F	1.4000	1.4975	1.0952	1.1447	1.0274	1.0287
		INTERCEPT-I ERROR	50/ 10	46/ 13	50/ 10	50/ 9	50/ 10	46/ 8
	FN	SLOPE-MEAN F	1.5000	1.4473	1.1000	0.9953	1.0278	1.1104
		SLOPE-I ERROR	50/ 10	50/ 9	50/ 10	42/ 9	50/ 10	60/ 14
		INTERCEPT-MEAN F	1.4000	1.4863	1.0952	1.0386	1.0274	1.0917
		INTERCEPT-I ERROR	50/ 10	42/ 8	50/ 10	40/ 7	50/ 10	62/ 17
ERROR= 33	RN	SLOPE-MEAN F	1.5000	1.3070	1.1000	1.1073	1.0278	1.0035
		SLOPE-I ERROR	50/ 10	44/ 5	50/ 10	63/ 9	50/ 10	39/ 8
		INTERCEPT-MEAN F	1.4000	1.3417	1.0952	1.1579	1.0274	0.9157
		INTERCEPT-I ERROR	50/ 10	44/ 7	50/ 10	56/ 8	50/ 10	48/ 14
	FN	SLOPE-MEAN F	1.5000	1.3483	1.1000	1.0967	1.0278	1.0321
		SLOPE-I ERROR	50/ 10	43/ 8	50/ 10	54/ 13	50/ 10	47/ 9
		INTERCEPT-MEAN F	1.4000	1.4646	1.0952	1.1295	1.0274	1.0122
		INTERCEPT-I ERROR	50/ 10	44/ 10	50/ 10	43/ 6	50/ 10	49/ 10
ERROR= 67	RN	SLOPE-MEAN F	1.5000	1.3557	1.1000	1.1030	1.0278	0.9851
		SLOPE-I ERROR	50/ 10	52/ 11	50/ 10	56/ 9	50/ 10	52/ 10
		INTERCEPT-MEAN F	1.4000	1.5364	1.0952	1.0346	1.0274	1.0352
		INTERCEPT-I ERROR	50/ 10	48/ 13	50/ 10	49/ 10	50/ 10	43/ 8
	FN	SLOPE-MEAN F	1.5000	1.3282	1.1000	1.1571	1.0278	1.0200
		SLOPE-I ERROR	50/ 10	40/ 9	50/ 10	43/ 15	50/ 10	39/ 7
		INTERCEPT-MEAN F	1.4000	1.4764	1.0952	1.1159	1.0274	0.9615
		INTERCEPT-I ERROR	50/ 10	46/ 12	50/ 10	61/ 12	50/ 10	45/ 6
ERROR=100	RN	SLOPE-MEAN F	1.5000	1.5032	1.1000	1.0675	1.0278	1.0385
		SLOPE-I ERROR	50/ 10	51/ 13	50/ 10	56/ 13	50/ 10	48/ 13
		INTERCEPT-MEAN F	1.4000	1.4474	1.0952	1.1226	1.0274	1.0067
		INTERCEPT-I ERROR	50/ 10	53/ 12	50/ 10	35/ 11	50/ 10	52/ 10
	FN	SLOPE-MEAN F	1.5000	1.3637	1.1000	1.1303	1.0278	0.9214
		SLOPE-I ERROR	50/ 10	58/ 12	50/ 10	50/ 7	50/ 10	61/ 16
		INTERCEPT-MEAN F	1.4000	1.5107	1.0952	1.0957	1.0274	1.0840
		INTERCEPT-I ERROR	50/ 10	43/ 12	50/ 10	46/ 12	50/ 10	34/ 4

TABLE 12 SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS (BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.3)

SAMPLE SIZE

			N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
ERROR= 0	RN	SLOPE-MEAN F	1.5000	1.4721	1.1000	1.1209	1.0278	1.0052
		SLOPE-I ERROR	50/ 10	51/ 9	50/ 10	47/ 12	50/ 10	58/ 12
		INTERCEPT-MEAN F	1.4000	1.4933	1.0952	1.0392	1.0274	1.0640
		INTERCEPT-I ERROR	50/ 10	55/ 10	50/ 10	51/ 12	50/ 10	52/ 8
	FN	SLOPE-MEAN F	1.5000	1.4380	1.1000	1.0765	1.0278	1.0415
		SLOPE-I ERROR	50/ 10	47/ 9	50/ 10	43/ 12	50/ 10	47/ 10
		INTERCEPT-MEAN F	1.4000	1.4420	1.0952	1.1166	1.0274	1.0052
		INTERCEPT-I ERROR	50/ 10	51/ 14	50/ 10	48/ 7	50/ 10	47/ 9
ERROR= 33	RN	SLOPE-MEAN F	1.5000	1.5160	1.1000	1.1299	1.0278	0.9792
		SLOPE-I ERROR	50/ 10	56/ 10	50/ 10	53/ 7	50/ 10	45/ 9
		INTERCEPT-MEAN F	1.4000	1.5570	1.0952	1.1355	1.0274	1.0215
		INTERCEPT-I ERROR	50/ 10	45/ 6	50/ 10	52/ 9	50/ 10	47/ 8
	FN	SLOPE-MEAN F	1.5000	1.4046	1.1000	1.0790	1.0278	1.0375
		SLOPE-I ERROR	50/ 10	43/ 8	50/ 10	43/ 5	50/ 10	50/ 9
		INTERCEPT-MEAN F	1.4000	1.4616	1.0952	1.0349	1.0274	1.0045
		INTERCEPT-I ERROR	50/ 10	43/ 12	50/ 10	49/ 10	50/ 10	55/ 13
ERROR= 67	RN	SLOPE-MEAN F	1.5000	1.3148	1.1000	1.0455	1.0278	0.9953
		SLOPE-I ERROR	50/ 10	41/ 4	50/ 10	48/ 13	50/ 10	54/ 14
		INTERCEPT-MEAN F	1.4000	1.3910	1.0952	1.0752	1.0274	1.0016
		INTERCEPT-I ERROR	50/ 10	48/ 8	50/ 10	40/ 8	50/ 10	51/ 8
	FN	SLOPE-MEAN F	1.5000	1.4333	1.1000	1.1194	1.0278	1.0250
		SLOPE-I ERROR	50/ 10	44/ 9	50/ 10	55/ 8	50/ 10	37/ 5
		INTERCEPT-MEAN F	1.4000	1.5136	1.0952	1.0893	1.0274	1.0191
		INTERCEPT-I ERROR	50/ 10	55/ 10	50/ 10	48/ 10	50/ 10	49/ 13
ERROR=100	RN	SLOPE-MEAN F	1.5000	1.5678	1.1000	1.0823	1.0273	1.0284
		SLOPE-I ERROR	50/ 10	52/ 12	50/ 10	63/ 14	50/ 10	51/ 10
		INTERCEPT-MEAN F	1.4000	1.6037	1.0952	1.1640	1.0274	1.0280
		INTERCEPT-I ERROR	50/ 10	64/ 13	50/ 10	43/ 8	50/ 10	44/ 11
	FN	SLOPE-MEAN F	1.5000	1.4202	1.1000	1.0345	1.0278	0.9811
		SLOPE-I ERROR	50/ 10	35/ 5	50/ 10	43/ 10	50/ 10	59/ 11
		INTERCEPT-MEAN F	1.4000	1.3108	1.0952	1.0546	1.0274	1.1070
		INTERCEPT-I ERROR	50/ 10	52/ 15	50/ 10	47/ 5	50/ 10	40/ 8

T[illegible] 2[illegible]. SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS: BIVARIATE NORMAL POPULATIONS, RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF [illegible] AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

SAMPLE SIZE

			N=5		N=13		N=33	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
ERROR= 0	RN	SLOPE-MEAN F	1.5000	1.4850	1.1000	1.0490	1.0278	1.0413
		SLOPE-I ERROR	50/ 10	54/ 8	50/ 10	55/ 14	50/ 10	53/ 9
		INTERCEPT-MEAN F	1.4000	1.4481	1.0952	1.1141	1.0274	1.0350
		INTERCEPT-I ERROR	50/ 10	54/ 13	50/ 10	53/ 5	50/ 10	54/ 7
	FN	SLOPE-MEAN F	1.5000	1.5427	1.1000	1.1372	1.0278	0.9627
		SLOPE-I ERROR	50/ 10	41/ 5	50/ 10	47/ 11	50/ 10	56/ 11
		INTERCEPT-MEAN F	1.4000	1.3129	1.0952	1.0740	1.0274	1.0908
		INTERCEPT-I ERROR	50/ 10	58/ 12	50/ 10	50/ 11	50/ 10	43/ 9
ERROR= 33	RN	SLOPE-MEAN F	1.5000	1.4632	1.1000	1.0677	1.0278	1.0252
		SLOPE-I ERROR	50/ 10	53/ 10	50/ 10	51/ 8	50/ 10	59/ 8
		INTERCEPT-MEAN F	1.4000	1.4661	1.0952	1.0893	1.0274	1.0803
		INTERCEPT-I ERROR	50/ 10	62/ 16	50/ 10	49/ 10	50/ 10	49/ 12
	FN	SLOPE-MEAN F	1.5000	1.3338	1.1000	1.1626	1.0278	1.3308
		SLOPE-I ERROR	50/ 10	42/ 5	50/ 10	54/ 12	50/ 10	55/ 11
		INTERCEPT-MEAN F	1.4000	1.2806	1.0952	1.1629	1.0274	1.1657
		INTERCEPT-I ERROR	50/ 10	49/ 10	50/ 10	61/ 13	50/ 10	58/ 12
ERROR= 67	RN	SLOPE-MEAN F	1.5000	1.3804	1.1000	1.0239	1.0278	1.1050
		SLOPE-I ERROR	50/ 10	54/ 13	50/ 10	47/ 7	50/ 10	50/ 10
		INTERCEPT-MEAN F	1.4000	1.6271	1.0952	1.1013	1.0274	1.0304
		INTERCEPT-I ERROR	50/ 10	50/ 9	50/ 10	45/ 9	50/ 10	54/ 12
	FN	SLOPE-MEAN F	1.5000	1.5764	1.1000	1.0810	1.0278	1.3130
		SLOPE-I ERROR	50/ 10	54/ 10	50/ 10	40/ 3	50/ 10	59/ 12
		INTERCEPT-MEAN F	1.4000	1.3613	1.0952	1.0326	1.0274	1.2754
		INTERCEPT-I ERROR	50/ 10	70/ 14	50/ 10	50/ 4	50/ 10	60/ 11
ERROR=100	RN	SLOPE-MEAN F	1.5000	1.4383	1.1000	1.1934	1.0278	0.8961
		SLOPE-I ERROR	50/ 10	41/ 5	50/ 10	42/ 6	50/ 10	50/ 10
		INTERCEPT-MEAN F	1.4000	1.3401	1.0952	1.0323	1.0274	1.0295
		INTERCEPT-I ERROR	50/ 10	51/ 14	50/ 10	54/ 20	50/ 10	31/ 8
	FN	SLOPE-MEAN F	1.5000	1.4531	1.1000	0.9653	1.0278	1.0360
		SLOPE-I ERROR	50/ 10	44/ 5	50/ 10	51/ 8	50/ 10	56/ 13
		INTERCEPT-MEAN F	1.4000	1.3593	1.0952	1.0947	1.0274	1.3362
		INTERCEPT-I ERROR	50/ 10	49/ 14	50/ 10	42/ 5	50/ 10	51/ 10

TABLE 21 SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS [illegible] RANDOM AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF [illegible] AND A VALUE [illegible] ESTIMATE BASED ON A CORRELATION OF 0.90

			N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
ERROR= 0	[illegible]	SLOPE-MEAN F	1.5000	1.2731	1.1000	1.1329	1.0278	1.0176
		SLOPE-I ERROR	50/ 10	43/ 11	50/ 10	50/ 9	50/ 10	47/ 7
		INTERCEPT-MEAN F	1.4000	1.4702	1.0952	1.1056	1.0274	1.0097
		INTERCEPT-I ERROR	50/ 10	39/ 7	50/ 10	47/ 8	50/ 10	54/ 11
	FN	SLOPE-MEAN F	1.5000	1.5472	1.1000	1.0990	1.0278	1.0804
		SLOPE-I ERROR	50/ 10	55/ 19	50/ 10	45/ 10	50/ 10	38/ 7
		INTERCEPT-MEAN F	1.4000	1.3422	1.0952	1.1101	1.0274	0.9658
		INTERCEPT-I ERROR	50/ 10	59/ 16	50/ 10	53/ 12	50/ 10	54/ 14
ERROR= 33	RN	SLOPE-MEAN F	1.5000	1.4263	1.1000	1.1493	1.0278	0.9788
		SLOPE-I ERROR	50/ 10	49/ 6	50/ 10	49/ 7	50/ 10	50/ 6
		INTERCEPT-MEAN F	1.4000	1.3605	1.0952	1.0535	1.0274	1.0265
		INTERCEPT-I ERROR	50/ 10	51/ 10	50/ 10	56/ 9	50/ 10	41/ 9
	FN	SLOPE-MEAN F	1.5000	1.8410	1.1000	1.2603	1.0278	2.2738
		SLOPE-I ERROR	50/ 10	45/ 6	50/ 10	55/ 10	50/ 10	52/ 12
		INTERCEPT-MEAN F	1.4000	1.4966	1.0952	1.1661	1.0274	1.6844
		INTERCEPT-I ERROR	50/ 10	80/ 15	50/ 10	65/ 9	50/ 10	58/ 16
ERROR= 67	RN	SLOPE-MEAN F	1.5000	1.3829	1.1000	1.0777	1.0278	0.9642
		SLOPE-I ERROR	50/ 10	52/ 12	50/ 10	51/ 4	50/ 10	43/ 7
		INTERCEPT-MEAN F	1.4000	1.5179	1.0952	1.0136	1.0274	1.0108
		INTERCEPT-I ERROR	50/ 10	58/ 10	50/ 10	44/ 10	50/ 10	42/ 9
	FN	SLOPE-MEAN F	1.5000	1.5612	1.1000	1.1608	1.0278	1.7389
		SLOPE-I ERROR	50/ 10	42/ 3	50/ 10	35/ 11	50/ 10	58/ 15
		INTERCEPT-MEAN F	1.4000	1.2115	1.0952	1.0149	1.0274	1.8596
		INTERCEPT-I ERROR	50/ 10	56/ 15	50/ 10	56/ 10	50/ 10	54/ 14
ERROR=100	[illegible]	SLOPE-MEAN F	1.5000	1.2730	1.1000	1.1237	1.0278	0.9924
		SLOPE-I ERROR	50/ 10	56/ 10	50/ 10	46/ 11	50/ 10	45/ 9
		INTERCEPT-MEAN F	1.4000	1.7063	1.0952	1.1270	1.0274	1.0268
		INTERCEPT-I ERROR	50/ 10	43/ 10	50/ 10	54/ 8	50/ 10	46/ 8
	[illegible]	SLOPE-MEAN F	1.5000	1.3538	1.1000	0.8281	1.0278	1.2393
		SLOPE-I ERROR	50/ 10	17/ 5	50/ 10	34/ 6	50/ 10	57/ 16
		INTERCEPT-MEAN F	1.4000	1.0772	1.0952	0.9906	1.0274	2.0209
		INTERCEPT-I ERROR	50/ 10	47/ 10	50/ 10	27/ 3	50/ 10	53/ 12

TABLE 2 [illegible] CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS [illegible] RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF [illegible] FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.0

SAMPLE SIZE

			N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
ERROR= 0	RR	SLOPE-MEAN F	1.5000	1.5544	1.1000	1.0760	1.0273	1.0436
		SLOPE-I ERROR	50/ 10	41/ 9	50/ 10	51/ 15	50/ 10	47/ 7
		INTERCEPT-MEAN F	1.4000	1.5257	1.0952	1.1574	1.0274	1.0275
		INTERCEPT-I ERROR	50/ 10	66/ 13	50/ 10	45/ 9	50/ 10	55/ 15
	FR	SLOPE-MEAN F	1.5000	1.5016	1.1000	1.0034	1.0278	0.9995
		SLOPE-I ERROR	50/ 10	43/ 9	50/ 10	51/ 9	50/ 10	50/ 12
		INTERCEPT-MEAN F	1.4000	1.4510	1.0952	1.0994	1.0274	1.0317
		INTERCEPT-I ERROR	50/ 10	44/ 12	50/ 10	41/ 8	50/ 10	44/ 9
ERROR= 33	RR	SLOPE-MEAN F	1.5000	1.3972	1.1000	1.1127	1.0278	0.9706
		SLOPE-I ERROR	50/ 10	53/ 12	50/ 10	44/ 9	50/ 10	50/ 13
		INTERCEPT-MEAN F	1.4000	1.6090	1.0952	1.0911	1.0274	1.0923
		INTERCEPT-I ERROR	50/ 10	50/ 12	50/ 10	48/ 11	50/ 10	43/ 7
	FR	SLOPE-MEAN F	1.5000	1.5133	1.1000	1.1558	1.0278	1.0618
		SLOPE-I ERROR	50/ 10	51/ 9	50/ 10	38/ 9	50/ 10	38/ 4
		INTERCEPT-MEAN F	1.4000	1.5776	1.0952	1.0619	1.0274	0.9393
		INTERCEPT-I ERROR	50/ 10	52/ 12	50/ 10	53/ 12	50/ 10	51/ 13
ERROR= 67	RR	SLOPE-MEAN F	1.5000	1.3230	1.1000	1.1556	1.0278	1.0258
		SLOPE-I ERROR	50/ 10	54/ 9	50/ 10	41/ 7	50/ 10	50/ 9
		INTERCEPT-MEAN F	1.4000	1.4951	1.0952	1.0455	1.0274	1.0280
		INTERCEPT-I ERROR	50/ 10	48/ 10	50/ 10	50/ 19	50/ 10	62/ 17
	FR	SLOPE-MEAN F	1.5000	1.5317	1.1000	1.0753	1.0278	1.0838
		SLOPE-I ERROR	50/ 10	48/ 12	50/ 10	50/ 10	50/ 10	53/ 9
		INTERCEPT-MEAN F	1.4000	1.4874	1.0952	1.1070	1.0274	1.0153
		INTERCEPT-I ERROR	50/ 10	47/ 11	50/ 10	42/ 13	50/ 10	69/ 16
ERROR=100	RR	SLOPE-MEAN F	1.5000	1.4188	1.1000	1.0500	1.0278	0.9670
		SLOPE-I ERROR	50/ 10	33/ 5	50/ 10	57/ 15	50/ 10	41/ 11
		INTERCEPT-MEAN F	1.4000	1.3316	1.0952	1.1779	1.0274	1.0072
		INTERCEPT-I ERROR	50/ 10	55/ 11	50/ 10	47/ 10	50/ 10	38/ 8
	FR	SLOPE-MEAN F	1.5000	1.2587	1.1000	1.0313	1.0278	1.0235
		SLOPE-I ERROR	50/ 10	46/ 11	50/ 10	43/ 11	50/ 10	61/ 13
		INTERCEPT-MEAN F	1.4000	1.5164	1.0952	1.1375	1.0274	1.0947

[illegible] SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS [illegible] LINES [illegible] FIRST [illegible] WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF [illegible] AND FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.30

SAMPLE SIZE

			N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
ERROR= 0	RR	SLOPE-MEAN F	1.5000	1.6570	1.1000	1.1928	1.0278	1.0195
		SLOPE-I ERROR	50/ 10	44/ 11	50/ 10	54/ 9	50/ 10	43/ 10
		INTERCEPT-MEAN F	1.4000	1.5686	1.0952	1.0934	1.0274	1.0118
		INTERCEPT-I ERROR	50/ 10	53/ 15	50/ 10	56/ 9	50/ 10	47/ 12
	FR	SLOPE-MEAN F	1.5000	1.3927	1.1000	1.0227	1.0278	0.8571
		SLOPE-I ERROR	50/ 10	62/ 17	50/ 10	59/ 11	50/ 10	32/ 1
		INTERCEPT-MEAN F	1.4000	1.7555	1.0952	1.1634	1.0274	0.8384
		INTERCEPT-I ERROR	50/ 10	48/ 10	50/ 10	36/ 14	50/ 10	25/ 4
ERROR= 33	RR	SLOPE-MEAN F	1.5000	1.2710	1.1000	1.0987	1.0278	0.9997
		SLOPE-I ERROR	50/ 10	51/ 12	50/ 10	52/ 10	50/ 10	47/ 9
		INTERCEPT-MEAN F	1.4000	1.6327	1.0952	1.1006	1.0274	1.0367
		INTERCEPT-I ERROR	50/ 10	45/ 7	50/ 10	57/ 11	50/ 10	50/ 7
	FR	SLOPE-MEAN F	1.5000	1.3775	1.1000	1.0362	1.0278	0.8837
		SLOPE-I ERROR	50/ 10	66/ 14	50/ 10	55/ 9	50/ 10	40/ 7
		INTERCEPT-MEAN F	1.4000	1.6696	1.0952	1.1313	1.0274	1.0114
		INTERCEPT-I ERROR	50/ 10	44/ 11	50/ 10	50/ 6	50/ 10	35/ 10
ERROR= 67	RR	SLOPE-MEAN F	1.5000	1.2628	1.1000	1.0590	1.0278	0.9737
		SLOPE-I ERROR	50/ 10	49/ 7	50/ 10	53/ 15	50/ 10	44/ 8
		INTERCEPT-MEAN F	1.4000	1.4334	1.0952	1.1194	1.0274	1.0023
		INTERCEPT-I ERROR	50/ 10	42/ 5	50/ 10	42/ 5	50/ 10	42/ 14
	FR	SLOPE-MEAN F	1.5000	1.4389	1.1000	1.0714	1.0278	0.9184
		SLOPE-I ERROR	50/ 10	52/ 5	50/ 10	56/ 12	50/ 10	45/ 11
		INTERCEPT-MEAN F	1.4000	1.3927	1.0952	1.1579	1.0274	1.0234
		INTERCEPT-I ERROR	50/ 10	50/ 13	50/ 10	55/ 10	50/ 10	38/ 7
ERROR=100	RR	SLOPE-MEAN F	1.5000	1.4851	1.1000	0.9572	1.0278	0.9816
		SLOPE-I ERROR	50/ 10	47/ 9	50/ 10	42/ 8	50/ 10	39/ 5
		INTERCEPT-MEAN F	1.4000	1.5121	1.0952	1.1112	1.0274	1.0023
		INTERCEPT-I ERROR	50/ 10	49/ 12	50/ 10	35/ 4	50/ 10	38/ 11
	FR	SLOPE-MEAN F	1.5000	1.2718	1.1000	1.0372	1.0278	0.9560
		SLOPE-I ERROR	50/ 10	56/ 15	50/ 10	44/ 9	50/ 10	45/ 11
		INTERCEPT-MEAN F	1.4000	1.5883	1.0952	0.9931	1.0274	1.0273
		INTERCEPT-I ERROR	50/ 10	39/ 9	50/ 10	47/ 11	50/ 10	49/ 6

[illegible] SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS [illegible] DISTRIBUTED [illegible] WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF [illegible] VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF ESTIMATE BASED ON A CORRELATION OF 0.60

SAMPLE SIZE

			N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
		SLOPE-MEAN F	1.5000	1.3583	1.1000	1.0669	1.0276	1.0230
		SLOPE-I ERROR	50/ 10	43/ 7	50/ 10	50/ 12	50/ 10	51/ 14
	RR	INTERCEPT-MEAN F	1.4000	1.4336	1.0952	1.0932	1.0274	1.0922
		INTERCEPT-I ERROR	50/ 10	51/ 8	50/ 10	42/ 9	50/ 10	46/ 9
ERROR= 0								
		SLOPE-MEAN F	1.5000	1.3796	1.1000	1.1058	1.0278	1.0921
		SLOPE-I ERROR	50/ 10	54/ 13	50/ 10	48/ 7	50/ 10	53/ 10
	ER	INTERCEPT-MEAN F	1.4000	1.6164	1.0952	1.0969	1.0274	0.9861
		INTERCEPT-I ERROR	50/ 10	50/ 14	50/ 10	52/ 9	50/ 10	58/ 9
		SLOPE-MEAN F	1.5000	1.4517	1.1000	0.9895	1.0278	1.1025
		SLOPE-I ERROR	50/ 10	38/ 10	50/ 10	48/ 6	50/ 10	34/ 8
	RR	INTERCEPT-MEAN F	1.4000	1.3871	1.0952	1.0746	1.0274	0.9915
		INTERCEPT-I ERROR	50/ 10	54/ 9	50/ 10	41/ 7	50/ 10	66/ 16
ERROR= 33								
		SLOPE-MEAN F	1.5000	1.4397	1.1000	1.0686	1.0278	1.1036
		SLOPE-I ERROR	50/ 10	50/ 19	50/ 10	46/ 11	50/ 10	55/ 15
	ER	INTERCEPT-MEAN F	1.4000	1.5771	1.0952	1.0990	1.0274	1.1138
		INTERCEPT-I ERROR	50/ 10	61/ 7	50/ 10	45/ 10	50/ 10	65/ 12
		SLOPE-MEAN F	1.5000	1.4578	1.1000	1.1254	1.0278	1.0631
		SLOPE-I ERROR	50/ 10	37/ 4	50/ 10	38/ 8	50/ 10	43/ 10
	RR	INTERCEPT-MEAN F	1.4000	1.3776	1.0952	1.0802	1.0274	1.0321
		INTERCEPT-I ERROR	50/ 10	55/ 16	50/ 10	47/ 11	50/ 10	54/ 14
ERROR= 67								
		SLOPE-MEAN F	1.5000	1.4127	1.1000	1.0233	1.0278	1.0815
		SLOPE-I ERROR	50/ 10	43/ 9	50/ 10	46/ 9	50/ 10	46/ 7
	ER	INTERCEPT-MEAN F	1.4000	1.3370	1.0952	1.0406	1.0274	0.9903
		INTERCEPT-I ERROR	50/ 10	50/ 13	50/ 10	55/ 7	50/ 10	53/ 12
		SLOPE-MEAN F	1.5000	1.2724	1.1000	1.1465	1.0278	1.0906
		SLOPE-I ERROR	50/ 10	53/ 9	50/ 10	46/ 12	50/ 10	51/ 10
	RR	INTERCEPT-MEAN F	1.4000	1.4764	1.0952	1.1030	1.0274	0.9916
		INTERCEPT-I ERROR	50/ 10	41/ 6	50/ 10	45/ 12	50/ 10	56/ 12
ERROR=100								
		SLOPE-MEAN F	1.5000	1.1325	1.1000	0.9563	1.0278	0.9734
		SLOPE-I ERROR	50/ 10	39/ 5	50/ 10	36/ 9	50/ 10	58/ 10
	ER	INTERCEPT-MEAN F	1.4000	1.2070	1.0952	1.0103	1.0274	1.1373
		INTERCEPT-I ERROR	50/ 10	40/ 9	50/ 10	47/ 3	50/ 10	41/ 5

[illegible] SOME CHARACTERISTICS OF THE CRITICAL STATISTICS FOR THE COMPARISON OF SLOPES AND INTERCEPTS [illegible] SLOPES RECTANGULARLY DISTRIBUTED BUT WITH THE Y VALUES NORMALLY DISTRIBUTED FOR EVERY VALUE OF [illegible] FIXED VALUES OF X, THREE SAMPLE SIZES, FOUR AMOUNTS OF ERROR, AND A VALUE OF ERROR OF [illegible] BASED ON A CORRELATION OF 0.90

SAMPLE SIZE

			N=5		N=13		N=39	
			EXPECTED	OBSERVED	EXPECTED	OBSERVED	EXPECTED	OBSERVED
		SLOPE-MEAN F	1.5000	1.3880	1.1000	1.1667	1.0278	1.0786
		SLOPE-I ERROR	50/ 10	54/ 9	50/ 10	42/ 6	50/ 10	55/ 13
	RR	INTERCEPT-MEAN F	1.4000	1.4573	1.0952	1.0328	1.0274	1.1175
		INTERCEPT-I ERROR	50/ 10	56/ 10	50/ 10	55/ 13	50/ 10	51/ 12
ERROR= 0								
		SLOPE-MEAN F	1.5000	1.4501	1.1000	1.1097	1.0278	1.0324
		SLOPE-I ERROR	50/ 10	52/ 7	50/ 10	56/ 14	50/ 10	47/ 14
	FR	INTERCEPT-MEAN F	1.4000	1.4045	1.0952	1.1086	1.0274	1.0100
		INTERCEPT-I ERROR	50/ 10	48/ 12	50/ 10	50/ 8	50/ 10	56/ 11
		SLOPE-MEAN F	1.5000	1.3065	1.1000	1.1154	1.0278	1.0621
		SLOPE-I ERROR	50/ 10	56/ 10	50/ 10	43/ 8	50/ 10	46/ 7
	RR	INTERCEPT-MEAN F	1.4000	1.5104	1.0952	1.0839	1.0274	0.9735
		INTERCEPT-I ERROR	50/ 10	45/ 5	50/ 10	47/ 9	50/ 10	54/ 7
ERROR= 33								
		SLOPE-MEAN F	1.5000	1.4552	1.1000	1.1090	1.0278	1.5058
		SLOPE-I ERROR	50/ 10	43/ 17	50/ 10	37/ 10	50/ 10	54/ 13
	FR	INTERCEPT-MEAN F	1.4000	1.4270	1.0952	1.0286	1.0274	1.3705
		INTERCEPT-I ERROR	50/ 10	53/ 13	50/ 10	47/ 10	50/ 10	63/ 15
		SLOPE-MEAN F	1.5000	1.3529	1.1000	1.1135	1.0278	0.9075
		SLOPE-I ERROR	50/ 10	46/ 5	50/ 10	32/ 2	50/ 10	41/ 7
	RR	INTERCEPT-MEAN F	1.4000	1.3202	1.0952	0.8984	1.0274	0.8923
		INTERCEPT-I ERROR	50/ 10	47/ 9	50/ 10	61/ 11	50/ 10	39/ 8
ERROR= 67								
		SLOPE-MEAN F	1.5000	1.1533	1.1000	0.8564	1.0278	1.2317
		SLOPE-I ERROR	50/ 10	25/ 3	50/ 10	25/ 1	50/ 10	54/ 13
	FR	INTERCEPT-MEAN F	1.4000	1.0496	1.0952	0.8126	1.0274	1.1081
		INTERCEPT-I ERROR	50/ 10	38/ 9	50/ 10	27/ 3	50/ 10	70/ 16
		SLOPE-MEAN F	1.5000	1.3439	1.1000	1.0831	1.0278	0.9836
		SLOPE-I ERROR	50/ 10	47/ 6	50/ 10	21/ 3	50/ 10	21/ 3
	RR	INTERCEPT-MEAN F	1.4000	1.2008	1.0952	0.8364	1.0274	0.7992
		INTERCEPT-I ERROR	50/ 10	44/ 10	50/ 10	46/ 11	50/ 10	41/ 8
ERROR=100								
		SLOPE-MEAN F	1.5000	0.8014	1.1000	0.7567	1.0278	0.9633
		SLOPE-I ERROR	50/ 10	19/ 3	50/ 10	17/ 2	50/ 10	80/ 21
	FR	INTERCEPT-MEAN F	1.4000	0.9509	1.0952	0.7204	1.0274	1.2824
		INTERCEPT-I ERROR	50/ 10	19/ 6	50/ 10	22/ 2	50/ 10	49/ 11

variable: (1) the concomitant variable is random rather than fixed; (2) the concomitant variable is fixed but contains error; and (3) the concomitant variable is random and contains error. The first of these three, which is a partial replication of the Calkins and Jennings (1972) study, can be examined by observing the results of the random and fixed sampling procedure (RN, random normal, and RR, random rectangular, versus FN, fixed normal, and and FR, fixed rectangular) for the various experimental conditions when the concomitant variable contains no error. The second aspect, the concomitant variable is fixed but contains error, can be examined by observing the results of the fixed sampling procedure (FN, fixed normal, and FR, fixed rectangular) for the various experimental conditions when the concomitant variable contains varying amounts of error. The third aspect, the concomitant variable is random and contains error, can be examined by observing the results of the random sampling procedure (RN, random normal, and RR, random rectangular) for the various experimental conditions when the concomitant variable contains varying amounts of error.

Examination of Tables 2-25 reveals that considerable variation occurs for the observed values (OBSERVED) obtained in the experiments. For the variance, skewness, and kurtosis of the distributions of intercepts and slopes, the means of the distributions of the critical statistics, and the number of Type I errors for intercepts and slopes, the observed values seem to vary about the expected values (EXPECT T and EXPECT O) with no particularly important discernable pattern which can be attributed to the factors varied in the experiments, with one exception. The exception is evident for the distributions of intercept and slope for samples of size five where some of the values of skewness and kurtosis are of sufficient magnitude that it seems unlikely that these values are distributed normally. Thus it appears that neither (1) amount of error of estimate, (2) shape of the distribution of the

concomitant variable, (3) sampling procedure for the concomitant variable, (4) sample size (with the exception noted above), or (5) amount of error in the concomitant variable are related to any sizable disruption of (1) the critical statistics for contrasts of slopes and intercepts, or (2) the variance or normality of the distributions of the values of intercept and slope.

However, examination of Tables 2-17 reveals considerable disparity between expected values for central tendency for the distributions of intercept and slope (EXPECT T - MEAN), which are based on knowledge of the specified population parameters, and the corresponding observed central tendency values (OBSERVED - MEAN). Since the magnitude of this disparity increases with increasing amounts of error and seems unaffected by change in the other factors which were varied, it would seem reasonable to conclude that the estimates of the central tendency values for distributions of intercept and slope are disturbed by error in the concomitant variable. This conclusion, however, overlooks a crucial lack of control in the procedure - the lack of control over the variance of the concomitant variable after the introduction of the error component. When an expected central tendency value (EXPECT O) which was computed from the observed characteristics of the bivariate and marginal distributions is compared to the observed central tendency values, the magnitude of the discrepancy is greatly reduced, and the observed values again appear to vary about the expected values with no particularly important discernable pattern which can be attributed to the factors varied in the experiments. Thus it appears that when the results are viewed in such a way that the lack of control of the variance of the concomitant variable is compensated for, neither (1) amount of error of estimate, (2) shape of the distribution of the concomitant variable, (3) sampling procedure for the concomitant variable, (4) sample size, or probably (5) amount of error in

the concomitant variable is related to any systematic disruption of the estimates of the intercept and slope values.

CONCLUSIONS

In the mathematical treatment of linear models, certain of the independent variables are assumed to be fixed variables (Graybill, 1961). When this assumption is made, it can be shown that the computed estimates of the parameters occurring in the models have the desirable characteristics that they are "good" estimates and are normally distributed.

It is often convenient to overlook this assumption when linear models are utilized in a research situation, since the nature of a variable often does not allow the researcher to select cases with particular values of a variable without discarding large amounts of data. This empirical study was undertaken as an attempt to discover the effects produced for the computed statistics and for the decisions made on the basis of a critical ratio concerning differences in these statistics for a particular family of linear models when certain independent variables are not fixed variables.

The assumption that certain independent variables have fixed values can be violated in one or both of two ways: (1) the researcher can fail to preselect values of the variables which will be found in the data and utilized to estimate the statistics, and/or (2) measurement error can be introduced through the process of observing the values of the independent variables. Calkins and Jennings (197[illegible]) reported that when certain independent variables are not fixed but are observed without error, the consequences of the violation of the assumption are negligible. The present study focused on the effects produced when the concomitant variable is either fixed or random but measured with error.

The particular family of linear models investigated are a set presented by Ward and Jennings (1973, pp. 138-148), who apply them to problems generally

approached by the use of the technique of analysis of covariance. The estimable terms in these models represent the estimates of the parameters of intercepts and slopes of group regression lines.

Three cases of the violation of the assumption that the concomitant variable is a fixed variable were investigated in this study. These three cases were (1) the concomitant variable is fixed but contains error, (2) the concomitant variable is random (partial replication of Calkins and Jennings, 1972), and (3) the concomitant variable is random and contains error. Three types of consequences of these three departures from the assumptions were investigated: (1) the estimates of the slope and intercept parameters are not "good," (2) the distributions of the values of these estimates are non-normal, and (3) the number of erroneous decisions concerning differences in the estimates are greater than expected.

In general the results of this study indicate that little discrepancy was evident between the observed and expected number of Type I errors resulting from any of the three cases of violation of the assumption. In addition, for none of the three cases did the distributions of the values of intercept and slope appear to be distributed other than normally except for samples of size five. Although there were differences of considerable magnitude between some of the expected and observed estimates of the intercept and slope parameters which appeared to be associated with amount of error in the concomitant variable, these differences were probably due to lack of control over the variance of the concomitant variable, since when the expected values were calculated utilizing the actual variance of the concomitant variable the magnitude of these differences was considerably reduced. Thus it appears likely that for none of these three cases of violation of the assumption are the estimates of the population values of intercept and slope seriously affected.

Probably only the tentative conclusion that the violation of the assumption that the concomitant variable be fixed and contain no error presents little or no problem for researchers should be drawn from this investigation. Before firmer conclusions are justified, the investigation should be repeated with better control of the variance of the concomitant variable when it contains error.

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